EDITORIAL

OUR attention has been called to an incorrect statement on page 221 of our June issue regarding tall chimneys. The tallest chimney in the world, instead of being in Japan, as was stated, is the one built by the Tacoma Smelting Company at Tacoma, Washington. The height of this chimney is 571 feet above the base and 601 feet above the foundation.

UNUSUALLY close bidding was recorded on a street-paving contract awarded at Santa Ana, California. The successful contractors bid $0.1449 per square foot for four-inch concrete pavement with an oil-and-screenings wearing-surface. Their only competitors bid $0.145 per square foot. The difference between the two bids on a $15,000 contract was only $10.14.

RIFLE-PRODUCTION by the Ordnance Department since the declaration of war against Germany has reached a total of 1,568,661 early in June. Of this number, 1,140,595 are of the modified Enfield type, model of 1917, 176,796 are Springfields, model of 1903, and 251,270 were originally manufactured for the Russian government. These Russian rifles are being used for training and for the equipment of home guards. All the other rifles are placed in the hands of soldiers destined overseas. In addition, at the outbreak of the War, the Army had on hand 600,000 Springfield rifles of the model of 1903. The present production is about 8000 per day, from five plants. Last winter, when eight plants were working on rifle-manufacture, the daily production was considerably larger, but since that time some of these plants have devoted part of their facilities to the manufacture of machine-guns and automatic pistols.

CONCRETE mixtures present a wide field for study, particularly with reference to the proper proportioning of the ingredients. The work done by Mr. Abrams' as reported in his article in another column has added considerably to our knowledge of this subject. Engineers have known for a long time that large proportions of water usually caused a weak concrete, but no one realized that the relation between proportion of water and strength was so direct that it could be expressed in the form of an equation. The condition of 'workability' is, however, the important factor. Anything that will increase the 'workability' of a relatively dry mixture, such as carefully graded aggregate, longer mixing, or the use of hydrated lime, is therefore of value. On the other hand, it is easy to over-estimate the importance of a dry mixture. Strength is not the only quality desired in concrete construction. In fact, for mass work it is relatively unimportant. Again, for concrete exposed to sea-water, resistance to corrosion is the important quality, and the tests made by Mr. R. E. Bakenhus at the Boston Navy Yard showed that concrete must be mixed wet in order to resist corrosion. In general, the question is a practical rather than a theoretical one. Certain methods of construction that add considerably to the cost, also add considerably to the strength. Whether these methods are advisable or not is a matter of judgment in each individual case.

RAILROAD financial statistics for the first four months of 1918 are the subject of a report recently issued by the Interstate Commerce Commission. The report covers all railroads having operating revenues above $1,000,000 for the year ended December 31, 1917, operating 233,000 miles of main line. While there was an increase in operating revenue, as compared with the first four months of 1918 of about $110,000,000, the increase in operating expenses was twice that amount. In consequence, net income decreased from $253,000,000 to $143,000,000. This reduction in revenue was mainly for the first three months of the year, when weather conditions were particularly unfavorable over a large part of the country. The net revenue for April 1918 was only $3,000,000 less than for April 1917. The number of 'short-line' railroads not taken over by the Government but included in the above returns is not stated, but it is probably relatively small. On the face of the April statistics, it might seem at first sight as if the Railroad Administration could have avoided the recent increase of rates, since the average revenue for the three years 1915, 1916, and 1917 was approximately the same as for 1917. However, while it is not expressly stated, it is reasonable to suppose that the back-pay of the railroad employees is not included in the returns. The recent increases of pay are estimated to amount to $300,000,000 per year, and besides there is, as stated above, a deficit of over $100,000,000 for the first three months of the year. If the Railroad Administration expects to 'catch up' before the end of the year, it must, therefore, during the next six months, increase the gross revenue of the railroads about $400,000,000, without considering any increases in the cost of materials or possible further increases in the cost of labor.

Is 'Joy-Riding' a War Necessity

As has frequently been mentioned in these columns, this country is at war. Such being the case, the deciding factor regarding any action should be 'Does it help or does it hinder winning the War?' This is just as true of the construction and maintenance of highways as it is of any branch of activity. California is justly proud of the many miles of good roads constructed by

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State and other agencies. Now comes the War, and the special need of conserving expenditures. On the other hand new roads must be built and other roads maintained if the maximum amount of freight is to be transported by motor truck. However, many of the present highways could, provided bridges and culverts were strengthened, easily carry the motor-truck traffic if it were not for the large number of passenger-automobiles. It is pleasure-touring added to freight-traffic that is breaking down the old macadam or gravel surface on these roads, and causing a demand for hard-surfacing that might not otherwise be required for several years. In cases where the pleasure use of a road does not destroy the surface entirely, it, nevertheless, is sufficient to increase the cost of maintenance considerably. Unnecessary passenger-traffic on the railroads is being discouraged in order that freight-traffic may be expedited. Should not freight-traffic on the highways also be given the right-of-way? It may be admitted that a large part, perhaps the majority of the passenger-use of the highways, is for legitimate business-purposes, and that the conscientious citizen will confine his pleasure-touring within reasonable limits. The question then becomes, how shall we restrain the 'joy-rider'? The use of pleasure-yachts has been practically forbidden by the issuance of an order depriving them of fuel.

One method of restraint is indicated in a resolution recently adopted by a sub-committee of the Committee on Highways of the Commonwealth Club, which, after summarizing some of the facts mentioned above, recommends that "in the new Federal revenue legislation now pending, a heavy tax be imposed on the sale of new automobiles, graded according to price so that the burden shall fall heaviest on the more expensive cars, and that the sale of ordinary pleasure-cars costing over $2000 be entirely prohibited." Such a measure would not solve the entire problem, no single regulation would, but it would be a step in the right direction. Furthermore, it would release manufacturing facilities and expert mechanics for aeroplane construction and other war-work.

'Joy-riding' must be curbed, if not stopped entirely. Our columns are open for suggestions as to how this may be done.

Engineering Council Seeks Helpers

The Engineering Council, as was designed, is engaging in numerous activities for the engineering profession of America, many of these activities being directly or indirectly connected with the War. The Council is a body of representatives from member-societies conducting most of its work through committees. For effectiveness these committees have usually a small number of members, although committee-membership is not limited to the representatives on the Engineering Council. Men have been selected for committee-membership because of broad knowledge and extended experience in the field. As the work of some committees develops, however, there are occasions when helpers are needed who can devote time to details, to special investigations, to getting local information in some community or State, to compiling and analyzing information already accumulated, or to scouting for men needed for some particular service. When need arises for such assistance it is often difficult to think of or to find the right man available at that moment. In order to meet this difficulty, to give a larger number of engineers a share in the activities, to broaden the Council's contact and gain greater breadth for its views and statements, as well as to make its work more widely known, the Engineering Council is requesting engineers who can help, to register their names and addresses, and in a general way stating the extent and nature of the service each is willing to render. This is an opportunity for some of the younger members of the profession to take a hand in society activities, but the request is not limited to the men of few years. Of course, every one registered may not be called upon or it may be a long time seemingly before a given volunteer is asked to help. On the other hand, calls may come promptly and frequently and opportunities may be afforded for service of no small value to the profession and the public.

To indicate a few lines of the Council's work, brief statements are given about some of the committees. The Public Affairs Committee reports on matters of public policy, and those relating to National, State, or local government, other than technical questions. One question of active interest now before this committee, for example, is that of licensing engineers.

The American Engineering Service has the duty of compiling as complete a classified catalogue of the engineers of America as it may be practicable to get together. Much information has been assembled, but a great deal remains to be collected. During war time lists collected by this committee and the engineering societies co-operating with it, are being used to supply thousands of names in response to calls from Government departments for specialists for combatant and other forces of Army and Navy and for the war industries. This committee frequently could use volunteers not only in New York but in distant communities, also in scouting for men to meet special and urgent calls from the Government, as well as in other ways. The War Committee of Technical Societies is engaged upon the examination of new inventions offered to the War and Navy departments and to stimulation of the development of useful new appliances for warfare. In reviewing ideas received, preparing bulletins and writing reports and records, this committee could make use of a number of helpers from time to time. The Water Conservation Committee is organizing to deal with questions of policy in various parts of the country concerning the utilization and control of water for such purposes as power development, navigation, irrigation, and municipal supply. This committee will need correspondents to aid it in keeping informed or in making special investigations about local laws and policies.

Engineers who are able and willing to take some part in this service for the profession should communicate with Alfred D. Flinn, Secretary of the Engineering Council, 29 West 39th St., New York.

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REVIEW OF THE MONTH

RECORDS in shipbuilding are broken so frequently nowadays as to occasion little comment. The recent launching of the destroyer 'Ward' at Mare Island Navy Yard deserves more than passing notice. The 'Ward' was launched 17½ days after the keel was laid. Furthermore the vessel was 84% complete at the time of the launching. The significance of these figures may be appreciated when it is remembered that similar vessels used to spend two years on the ways.

CONSTRUCTION of the bascule bridge across the Oakland estuary will probably be postponed until after the War as a result of a recent decision of the War Department. At the same time Alameda county is authorized to proceed with the preparation of plans and the acquirement of right-of-way, so that no time may be lost when conditions become more favorable to construction. Although the War Department is of the opinion that the proposed bridge is not a war necessity, the construction of ships for the Emergency Fleet Corporation at the various yards along the estuary is hindered considerably by the present slow-opening drawbridges. A change of policy is therefore possible that will permit building the bridge before the end of the War.

MONTHLY reports of oil-production in California, formerly issued separately by the Standard Oil Company and the Independent Producers' Agency, are to be discontinued at the suggestion of Mr. Mark L. Requa, Federal Fuel Administrator. The statisticians of both organizations are to combine their efforts and a single report is to be issued monthly by the Pacific Coast War Service Commission, which consists of representatives of the principal producing companies. The discrepancies for the former reports, while usually slight, were for some months considerable, and it is believed that a joint report will be more accurate and more useful to the industry and to the general public.

THIS change of policy has caused a delay in the appearance of the May report. Some decrease in consumption is probable in the North-West as a result of substitution of coal for oil. On the other hand, most industries in California are increasing their consumption, and the power companies will be compelled to run their steam-plants at their fullest capacity from now until the fall or winter rains increase the supply of water for hydro-electric plants. As there is no reason to believe that there was any material increase of production, it is probable that May will show the usual reduction of the amount of oil in storage. A further drain on the perilously small stock in storage will be felt soon, when the tank-steamers that have been running between Tampico and Chilean ports are placed on the San Francisco-Chile run. The production and shipment of nitrates from Chile are essential to war-work, and the recent activities of submarines on the Atlantic Coast make it necessary to withdraw these tank-steamers from the Gulf of Mexico. The requirements of Chile, amounting to 600,000 barrels per month, must hereafter be supplied from California. Meanwhile, the land-leasing bill is still in conference at Washington. Until some definite action is taken permitting development of the withdrawn oil-land, there is no hope for a material increase in Californian oil-production. Even after such legislation has been passed it will take several months to drill the wells needed to stop the drain on storage.

CONCRETE-SHIP construction on a large scale for the Emergency Fleet Corporation will soon commence at five different yards, three on the Atlantic and two on the Pacific Coast. Construction of eight ships at each yard has been authorized. The two Pacific Coast yards will be at Government island on the Oakland estuary, and at some point on San Diego bay. The new ships will have a carrying-capacity of 7500 tons, against 5000 tons for the 'Faith.' The shape of the new vessels will also be different, being similar to the standard molded shape for steel and wooden vessels, instead of the straight lines and sharp angles of the 'Faith.' Changes will also be made in the thickness of the concrete and the arrangement of reinforcement. The fact that changes have been found necessary should not be taken as indicating in any way that concrete is not a suitable material for vessels or even that the design of the 'Faith' was faulty. It took years of service-tests of actual vessels to develop the present standard designs for steel ships and it may take as long before concrete-ship design is similarly standardized. Sufficient progress has already been made to show that concrete has a place as a shipbuilding material. How large that place will be, time alone can tell.

CO-ORDINATION of highway work throughout the country is provided by the appointment of the United States Highways Council, composed of L. W. Page, chairman, representing the Department of Agriculture and the Office of Public Roads; W. D. Uhler, representing the War Department; Richard L. Humphrey, representing the War Industries Board; G. W. Kirtley, representing the Railroad Administration; and C. G. Sheffield, representing the Fuel Administration. This step was taken at the suggestion of the Secretary of Agriculture in order to prevent delays, financial loss, and uncertainty caused by the system of considering each highway problem in its turn by a separate and distinct

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Government agency. All questions regarding highway work, whether pertaining to finance, materials, transportation, or war necessity are referred to the Council. A form has been prepared on which applications for relief are to be made through the various State highway departments, and a supply of these forms has been sent to each department. In order to conserve money, transportation, labor, and materials, highway and street work should be restricted as much as possible. The Council places maintenance of existing streets and highways as of first importance; next comes reconstruction of badly damaged streets and highways; and, lastly, new construction that is either a war or an economic necessity. It is to be hoped that the co-ordination of highway work throughout the country will continue in some form or other after the War. Such complete control as is now being exercised will probably be unnecessary when normal conditions return, but as Mr. Page shows in his article on 'Military Highways' in another column, co-ordination of highway construction and maintenance is just as important in time of peace as it is in time of war. Motor transportation has already turned county highways into State highways and is turning these State highways into National highways. Meanwhile, only a small proportion of the total amount expended on highway work has been spent in accordance with any definite general plan.

CENTRALIZED control and operation of all electric-power companies in California operating north of Merced has been established by the companies working with the State Railroad Commission to meet the threatened power-shortage. This shortage is caused partly by the great increase in the demand for power for war industries, and partly by the fact that the companies have been unable to raise money for needed extensions, but is mainly the result of the unprecedentedly low rainfall and run-off of the past two seasons. Power companies operating north of Merced use 60-cycle current, while companies operating south of that point, beginning with the San Joaquin Light & Power Corporation, use 50-cycle. For this reason the two problems must be considered separately. It is also true that for various reasons, among them being the greater proportionate run-off and smaller number of war industries in southern California, the danger of a power-shortage, while considerable, is not so great as in northern California.

THE first step toward meeting and, if possible, averting the shortage was the appointment of a committee of seven representatives from the power companies to work with the State Railroad Commission in arranging for the distribution of power throughout northern and central California. Mr. H. G. Butler, formerly assistant chief engineer for the Commission, has been appointed head of the newly-created department of power administration. Work is now under way for connections between the systems of the California-Oregon Power Company, the Northern California Power Company, and the Pacific Gas & Electric Company. The California-Oregon company has a surplus of power from its plant recently completed at Copco. This power, the only surplus power existing in California at the present time, is to be delivered to the Northern California Power Company, which will enable the Northern California company, in its turn, to deliver to the Pacific Gas & Electric Company power that is sorely needed for consumers in the San Francisco Bay district. In addition to providing for the use of this 'block' of hydre-electric power, arrangements have been made for the operation at full capacity of the steam-plants of all the companies, and a request has been made that consumers conserve power as much as possible. No priority list has been issued and the issuance of such a list will be postponed as long as possible. If conditions compel the issuance of a priority list, it will be done only after consulting all the interests involved, as well as the representatives of the Food, Fuel, and other Federal Administrations. Mr. D. M. Folsom, Federal Oil Administrator for the Pacific Coast district, has stated that power companies will continue to receive oil, although if a priority list on oil is established cutting off any given class of consumers from direct use of oil, the companies will not be furnished with oil for the manufacture of power to be delivered to that class of consumers.

IF a priority list is established it will probably follow the general plan of one that has already been prepared. This places breweries, beer-bottling works, wineries, and distilleries at the bottom of the list. Then follow in the order named, quarries, rock-crushers, marble and granite works, electric signs and billboards, brick and clay-products manufacturers, cement-mills, gold-dredges, mines, lumber and planing-mills, paper and paper-box factories, garages and other automobile industries, printing and lithographing, furniture factories, building and construction work, elevators, electric railways, sheet-metal, hardware, and plumbing factories, ice-cream factories, laundries and cleaners, typewriters, moving-picture houses, paint, tent, cordage, and bag factories, wire works, match factories, oil refineries, salt works, can factories, tanneries, clothing factories, newspapers, cold-storage and ice-plants, chemical works and smelters, packing-houses and canneries, iron works, foundries, and machine-shops, reclamation and irrigation districts, sugar refineries, bakers and macaroni factories, flour and feed mills, grain-warehouses, shipbuilding plants, wireless telegraph companies, and Government work. At first sight, almost anyone will be inclined to think that he could prepare a much better list. A little study should, however, show that, in order to make a good priority list, one must know a great deal about many different things. For instance, ice-cream has a relatively good position on the list because it is a good way to use the surplus dairy products that necessarily accumulate in summer if we are to have enough of such products during the winter. Investigation would probably show good reasons for other relative positions that do not seem reasonable at first, such as placing smelters near the top of the list, while the mines supplying the smelters are near the bottom.

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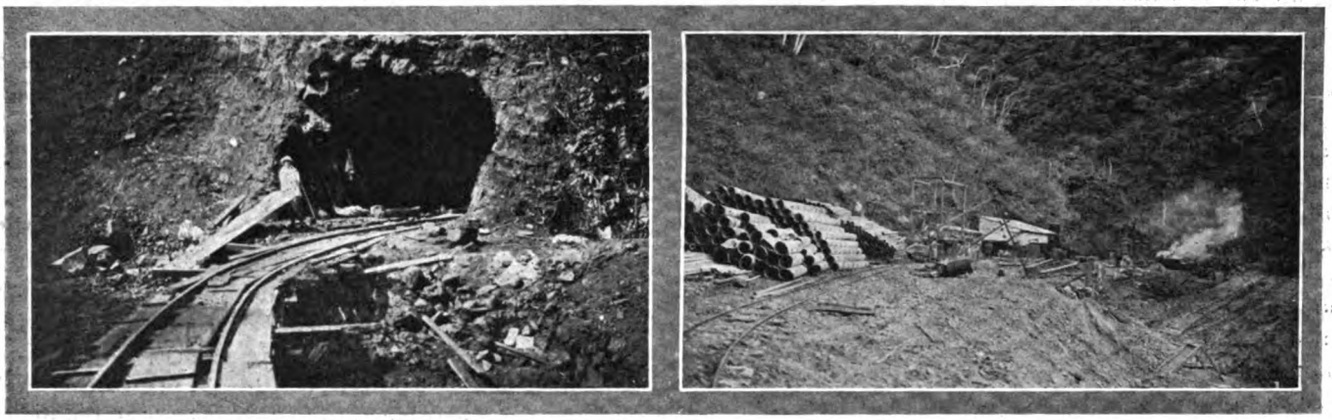


NORTH PORTAL BEFORE PLACING MACHINERY

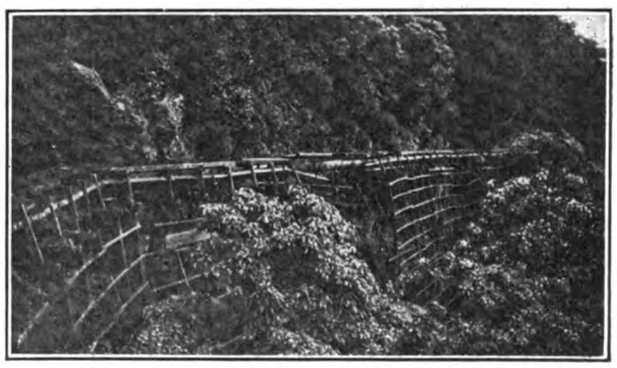
VICINITY OF SOUTH PORTAL

The 7000-Foot Tunnel at Lahaina, Hawaii

By Fr. KOELLING

On the south-western side of the island of Maui, second in size of the Hawaiian group, are situated the properties of the Pioneer Mill Co., Ltd., comprising some 28,000 acres. Of this area, 9500 acres is applied to the cultivation of sugar-cane, the principal industry of the islands. Owing to the low average rainfall over the lower cultivated area at Lahaina, an extensive irrigation system is maintained. To give an adequate idea of the enormous amount of water required for a plantation of the extent of Pioneer, it is only necessary to state that between 85,000,000 and 100,000,000 gallons of water is used daily, of which quantity 40% is furnished by high-lift pumps. Water is lifted by the pumps from wells at sea-level to an average head of 260 ft. The remaining 60% is supplied by mountain streams and tunnels, the latter forming the subject matter of this article. In the mountains back of Pioneer is situated the beautiful Honokowai gulch, one of the grandest and most picturesque to be found on Maui. Far back in the narrowest part of the gulch, under heavily forested and almost perpendicular cliffs that tower above it some 1000 ft., is situated the north portal of the 7000-ft. Honokowai tunnel which is being constructed to replace a semi-circular galvanized-iron flume that has been used since 1898. Although parts of this flume are still in fairly good condition and would have lasted for several years more, the redwood trestles had deteriorated to such an extent that the Pioneer Mill Co. concluded to abandon it altogether. The tunnel will not only have the advantage of permanency, but will also have ten times the present capacity of the flume.

The tunnel, which is situated at an elevation of 1525 ft., is of horse-shoe section, 6 by 6 ft. inside of concrete lining, and is designed for a capacity of 50,000,000 gal. daily. Power for the tunnel is furnished by hydro-electric stations, operated in synchronism, having a total capacity of 2000 kva. The nearest station is at an elevation of 940 ft., 11,000 ft. distant from the north portal and 8500 ft. from the south portal, as measured along the transmission-lines. The transmission-line consists of three No. 6 galvanized iron wires (later to be used for fence purposes) strung on proper insulators of temporary construction, carrying 6600 volts, which is stepped down to 440 at the portals. The longest span is 700 ft., across a gulch on the south-portal line. This line branches from the north-portal line 4000 ft. from the power-house, and this latter section carries 250 kva.; 40 kva. for the blacksmith-shop there, 120 kva. for the



OLD FLUME IN HONOKOWAI GULCH

north portal, and 90 kva. for the south portal. This station derives its power from the Honokowai stream and from water developed from mountain tunnels, and on completion of the tunnel will be enlarged and moved to a new place.

The machinery for the north heading consists of one 10 by 10-in. Laidlaw-Dunn-Gordon compressor with 50-hp. motor, one 8 by 8-in. Ingersoll-Rand compressor with 35-hp. motor, one size 5 type B American blower, with 15-hp. motor, one Allis-Chalmers motor-generator set of 12½ kw., one 3½ by 10½ ft. air-receiver, one three-

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ton Jeffrey locomotive with Edison battery, cars, rails, pipe, lumber, transformers, etc. This was all hauled by Holt caterpillar traction engines to an elevation of 2500 ft., directly above the north portal. At this point, an A frame with sheaves, 'dead-men', etc., was erected and a $\frac{3}{8}$-in. steel cable run to the opposite side of the gulch and anchored to a number of large trees, 300 ft. above the bottom of the gulch and opposite the portal. The cable was drawn taut by the 45-hp. caterpillar engine traveling down the mountain road, after which the load was hung on two sheaves running on the cable and slacked down by a 3-in. manila rope until it was directly above the bottom of the gulch, when both cable and rope were slacked together and the load landed at the portal. The heaviest load weighed $2\frac{1}{4}$ tons.

The south portal is in a gulch, and a 12-ft. road, 1500

LOWERING AIR-RECEIVER FOR COMPRESSOR, SHOWING PRECIPITOUS CHARACTER OF COUNTRY

ft. long, was constructed along its side on the grade of the distribution ditch which will later take its place. The machinery for this end was hauled by Holt caterpillars directly to the portal. It consists of one 16 by 14-in. and 10 by 14-in. duplex, Imperial type 10, Ingersoll-Rand compressor with 100-hp. motor direct connected, one $12\frac{1}{2}$-kw. Allis-Chalmers motor-generator set, two No. 4 Sturtevant blowers with 3-hp. motors, one 4 by 6 by 8-in. duplex Worthington pump, and one Jeffrey electric locomotive, transformers, etc. A blacksmith-shop situated at the main camp half-way between the two portals is equipped with one 8 by 8-in. Laidlaw-Dunn-Gordon compressor, 20-hp. motor, No. 635 Leyner sharpener, forge, drill-press, emery wheels, etc. The steel is sharpened with a four and five-point regulation Leyner die and plunged for tempering.

In the north heading, two No. 18 Leyner drills and four sets of $1\frac{1}{4}$-in. hollow steel from 24 to 96 in. are used, one machine drilling 6 ft. per hour and averaging 1150 cu. ft. of free air at 80 lb. pressure per lineal foot of hole drilled. The water for the drills and compressor is taken from the stream at an elevation far enough above the portal to give 45 lb. pressure. The air-line is 2 in., and the water-line 1 in. galvanized-iron pipe. In the south heading, two No. 9 Leyner drills and four sets of $1\frac{3}{8}$-in. hollow steel from 24 to 96 in. are used. The pressure maintained at the compressor is 90 lb. per sq. in., and there is a large surplus of air. The water for the drills is forced into the tunnel and compressor by a 4-in. Worthington duplex pump, regulated to 40 lb. pressure and operated by air. Three shifts of two drillers, two helpers, three shovelers, and a shift-boss are employed. A 7-ft. round of from 10 to 16 holes is drilled in 7 hours, one hour being taken up in setting-up a bar twice, loading holes, etc. The drills are mounted on horizontal bars; several shoveling-sheets 5 by 5 ft., stone picks, and square-pointed shovels are used. The ventilation in the north heading is supplied through an 8-in. pipe from the blower making 2400 r.p.m., under a pressure of 2 lb. per sq. in. At the south heading 16-in. pipe is used, the blowers making 1800 r.p.m. under very low pressure. Immediately after blasting the blowers exhaust for 20 minutes and thereafter force fresh air continually into the tunnel. Underground currents of air have been encountered, at times sufficient to extinguish a candle when applied to the vent. This aids ventilation somewhat. For illumination, 50 and 75-watt, 110-volt Mazda lamps are used. The main camp, power-house, and both portals are connected by telephone, which can be connected to the plantation system when necessary.

The rock penetrated is of volcanic origin, consisting of two main varieties: (1) Trap rock, a hard, blue, flinty rock, in dikes of from 2 ft. to 100 ft. in width. And (2) water rock, a hard porous rock, containing many olivines and a burnt, crumbly, formation interspersed. In drilling this porous rock, much time is lost in extracting the larger drills on account of its crumbly nature. This tends to pack around the drill causing it to stick in the hole. It is often necessary to 'shoot' a drill, and when loading, the holes become 'dogged' with small rocks. In driving a similar tunnel on the island of Oahu, 750-ft. elevation, water was encountered after each vertical dike had been drilled through on the windward side of the island, until about 2000 ft. past the middle of the range. No water has been encountered in the Honokowai tunnel. This may be explained by its being on the leeward side of the island, the water draining to the windward and more precipitous side. Gelatine powder, 40%, triple-tape fuse, and No. 6 caps are used. Fifty pounds of powder breaks about $4\frac{1}{2}$ ft. The only timbering necessary was between station 16+30 and 17+00 in the north heading where a cave-in took place, caused by the loose nature of the rock. The waste is transported in side-dump, 1-yd.

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Koppel cars, and hauled by a three-ton Jeffrey electric locomotive. The track is 24-in. gauge.

The machine-drills were started in the north heading on August 5, 1917, and in the south heading on October 7, 1917, 950 ft. having been driven by hand. The two headings were brought together on March 30, 1918, 3802 ft. from the north end and 3198 ft. from the south end; the centre line was out 6 in., the grade and distance being correct.

The actual time of excavation was 10 months. Had all the equipment been in operation from the start, the tunnel could have been excavated in 7 months. The maximum monthly progress was made in December, 1054 ft. being driven in 28 days, or an average of 37.64 ft. per day. The cost per foot for the excavation has been approximately $11, and the cost of lining the tunnel is estimated at $2, which will bring the cost of the main tunnel to $13 per foot. Two feet of the sides and floor of the tunnel are now being concreted, the aggregate being taken from the dump. A small crushing plant with sand rolls, etc., has been erected at the south adit. Two mixers operated by gasoline are in use. In connection with this tunnel, a feeder tunnel of 25,000,000-gal. capacity, 813 ft. long, and three lateral tunnels of 35,000,000 gal. capacity, 1152 ft. long, have been completed. Two intakes are in course of construction, and a concrete flume at the south portal, 2700 ft. of supply ditch, pipeline, and storage reservoir remain to be built.

Operation of Imhoff Tanks*

By GEORGE W. FULLER

1. Small plants of the Imhoff-tank type, receiving the flow of separate sewers, are frequently more difficult to operate than larger ones receiving the flow of combined sewers, because the relatively large size of the suspended particles reaching the digestion chamber respond for long periods at a time to flotation rather than sedimentation.

2. Careful attention to the prevention or frequent removal of stranded solids in the collecting sewers, inlet channels of the tanks and on the bottom and sides of the upper sedimentation compartment; to the uniform distribution of solids in the several sections of the tanks; to the frequent removal of grease and scum from the surface of the sedimentation compartment, is helpful and important. But these precautions will not necessarily eliminate abnormally long periods for the 'ripening process,' following which well-digested sludge is obtained without objectionable odors.

3. Normal digestion of sludge to an inodorous humus mass, with a fairly uniform liberation of the resulting gases caused by the inevitable splitting apart of carbon, hydrogen, nitrogen, and sulphur atoms contained in the complex molecules of suspended organic substances, is seemingly effected by enzymes or liquid ferments excreted by certain kinds of bacteria.

4. When tanks are new, and when for any unforeseen reason old tanks lose their efficient digestive functions, ordinary bacterial decomposition predominates over enzyme digestion; with attending possibilities as to odor complications for incompletely digested sludge, or from the release of intermediate decomposition products, particularly those of a sulphurous nature, or from both. Tanks in this condition are said to be undergoing the 'ripening process,' which fortunately does not seem to be necessary as a rule other than with new tanks, although there have been some exceptions to this general experience.

5. There is no way of telling in advance how long a period of ripening may be necessary for a given tank, as different results come in different units of the same plant. Some kinds of bacteria grow prolifically and preclude the development of suitable enzyme-producing bacteria as a result of 'bacterial antagonism' caused by the excretion of waste products. This may be as capricious a matter as the occurrence of weeds in a field of algae in an unpolluted lake. 'Seeding' a tank with ripened sludge from another tank is not as reliable a method of improving conditions as was formerly believed.

6. Objectionable odors may arise in varying degree, depending upon local factors, but largely upon the lack of opportunities for absorption of odoriferous compounds by surrounding water and upon accumulations of gas that may be released intermittently following barometric changes and interruptions in free venting.

7. The secret of success in operating Imhoff tanks is to retain in them relatively small quantities of decomposing solids and to do all that is practicable to secure a proper balance between enzyme liquefaction and bacterial decomposition with a predominance, of course, of the former. This explains why tanks receiving only relatively small quantities of sewage digest sludge so well, even when still new.

8. Quiescent masses of sewage solids, either scum or bottom-sludge, are scarcely capable of satisfactory decomposition as antagonistic products of bacterial life seem to have a decidedly retarding effect.

9. Lime will lessen excessive acid formation in sludge, but it is not likely to cause the establishment of the right kinds of bacteria for enzyme production. In fact, it may result in increasing abnormalities.

10. Agitation through pressure water-jets or pad-

*From paper read at meeting of New Jersey Sewage Works Association.

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dling may be of assistance. In Europe mechanical stirring-devices have been proposed. The benefit of stirring and mixing seems to lessen with increasing volumes of sewage solids in a tank, because of a loss of efficiency of the stirring arrangements. This step, if carried too far, may also remove entrained gas to such an extent that non-gaseous, sticky, foul-smelling sludge is obtained under circumstances requiring its removal and burial, or else treatment with a deodorant.

11. Acid foaming at gas-vents sometimes becomes troublesome when the gas-vents contain large quantities of floating scum undergoing bacterial decomposition in the absence of adequate enzyme digestion.

12. Slot trapping by gas and gas-lifted solids, which fill the space above the slots, frequently accompanies foaming and may carry decomposing solids into the settling-compartment from the sludge-chamber below.

13. Overflowing from foaming cannot be stopped in some tanks even if the gas-vents are extended five or ten feet or even more above the flow-line. High free-board, housing with water, stirring and liming, all help, but collectively may not be a prompt cure. Aggravated cases are not cured by putting a tank out of service for months. In some tanks removal of sludge from the bottom is a remedy, but this is not available for tanks containing most of the solid matter in a floating condition. The sure remedy then is to remove the great bulk of floating solids from the gas-vents until only small quantities remain. Obviously such removal must be done in a way to minimize offense.

14. Scum-storage for floating solids above the elevation of the slot should be provided for much more liberally than hitherto for small plants that are expected to receive during the first year of their operation a substantial proportion of the normal daily quantity of sewage.

15. Scum-removal may be necessary in some plants even where there is fairly liberal allowance for scum-storage. It depends partly on intensity of gasification, partly on the adhesiveness of the scum (gas-retaining capacity), and partly on the success attending efforts to make portions of the sludge remain in the lower part of the digestion-chamber.

16. Scum-prevention is sometimes obtained by comminution incident to pumping and may be further aided through the use of screens. Sometimes screening is provided in front of the pumps. At Rochester, N. Y., the flow of a gravity outfall-sewer now passes through a fine screen on its way to Imhoff tanks. Similar provision has been recommended at Plainfield, N. J. Such a step adds materially to the cost of sewage treatment, but evidence at Reading, Philadelphia, and Chicago shows that it reduces scum-formation to a substantial degree. Its advisability for a given project depends upon whether the need is commensurate with the cost.

17. Normal Imhoff sludge is dark-colored, practically inodorous, and shows a curdled appearance when it flows in a thin layer down the side of a container. Much difficulty with odor has followed the withdrawal of undigested sludge to a drying-bed. An operator should carefully note the condition of the sludge before and during its removal. But difficulty has also been caused by retaining sludge for a year or more in a tank under conditions where suitable enzyme digestion does not prevail. Such sticky gray or yellowish sludge may be foul-smelling, but it is wisest in some cases to remove it, taking care to prevent nuisance from odors. Complete digestion, although desirable, is not always attainable.

18. Idle tanks and conduits should be emptied; otherwise offensive odors may ensue.

CALIFORNIA OIL STATISTICS FOR 1917

The California State Mining Bureau has completed the compilation of the amounts of oil and gas produced during 1917. The figures are based on sworn statements from all producers and show a total petroleum production of 94,433,547 bbl. This is an increase of 7,370,352 bbl. over the amount reported for 1916. The official figures are less than the figures published by private concerns. The latter, however, make no allowance for water and other impurities in the oil when first produced and gauged. There were no additions of importance during 1917 to the proved oil-land area as determined by the State Mining Bureau for assessment of 1916. The new Montebello field was the outstanding feature of the year. There was an increase in production in every petroleum-producing county in the State. Los Angeles county showed the largest increase, 52%, over last year's production. There were 984 wells started for drilling, during 1917.

The rate of assessment, levied to support the work of supervision of drilling operations, so as to protect the fields from damage by water, is based on the amounts of oil and gas produced and of proved oil land. The rate for the coming year amounts to $0.146 per acre of proved oil land and $0.00119 per barrel of oil or per ten thousand cubic feet of gas. The total amount to be collected is about $130,000.

County	Land, acres	Oil, bbl.	Gas, cu. ft.	Wells	Average production per well per day, bbl.
Fresno	12,993	16,146,797	591,890,000	1,131	39
Kern	56,947	52,688,711	19,275,060,000	4,716	31
Los Angeles ..	2,401	4,357,162	241,750,000	748	16
Orange	3,418	14,568,930	6,550,270,000	467	85
Ventura	1,726	989,726	.....	355	8
Santa Barbara	9,023	5,589,223	601,570,000	385	40
San Luis Obispo	772	74,143	.....	18	11
Santa Clara ..	80	18,855	.....	14	4
Total	87,360	94,433,547	27,260,540,000	7,834	33

In soldering copper to iron, salammoniac (ammonium chloride) shoud be used as a flux. For example, if it is desired to solder a copper wire to an iron rod, file the rod until it is bright. Then heat it, applying powdered salammoniac in the meantime and 'tin' it with solder. After this has been done, the 'tinned' copper wire can be soldered to the iron quite readily.—'National Engineer.'

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An Optical War*

By RANSOM PRATT†

This War, because it is so widespread and practically covers the whole world, is not simply a military contest, but includes all phases of human activity. It is no longer a war between monarchs and diplomats, but is essentially a life-and-death struggle of peoples. So vast are the interests involved, that we might call it a war of almost any special activity, and be safely within the truth. For the reason of its close association with my business, I have become particularly impressed from the beginning in 1914 that it might with great reason be called an Optical War. For, in any branch of the service, on land or sea, optical products are an indispensable, imperative, vital necessity.

The typical war painting of the past pictures a battlefield, with the commander-in-chief standing on a knoll in the foreground, watching the movements of troops through an old-fashioned single-barreled 'spy-glass.' Later, when binocular field-glasses were devised, they were used, not only by the commander-in-chief, but also by his generals. Soon, it was found desirable for the regimental commanders to have them. The production of the compact prism-type of field-glass, furnished an instrument of lighter weight and of much clearer and more effective vision. Today all commissioned officers in the field find a prism-binocular field-glass a necessity, and the demand on the manufacturers is beyond the equipment or capacity of any factory.

It is the same in the Navy. A battleship would be helpless without the eyes furnished by the field-glass. Where guns are fired miles instead of yards as formerly, a clear view of the enemy at long distances is obviously vital. The use of the submarine has multiplied the need of effective field-glasses. A periscope cannot be seen at a great distance with the naked eye, even when the sea is smooth; and when the water is rough it is difficult to pick it up, even with a powerful field-glass. In artillery work, not much can be done, I am speaking comparatively, without high-grade field-glasses. I recently received a letter from an artillery officer at Fort Sill, Oklahoma, which said that the day before he had lost several 'points' because he could not properly gauge his firing when using the weaker and older type of field-glass. In action, the 'points,' which are represented on paper at a training camp, become human lives. There is now an additional refinement in field-glasses for officers, known as the mil scale, and Eames Range-Corrector Scale, which not only enables them to calculate distances, but also is a valuable adjunct in directing gun-fire.

As we all know, the submarine is blind without its periscope. By the use of lenses and reflecting prisms, the officer below the surface of the water can scan the horizon and find his enemy. The main periscope is fixed to the vessel, but the Germans use a supplementary periscope, in case the main one is shot away, which, as we understand, can be temporarily pushed above the surface. It is a small pipe scarcely visible at ordinary distances, and the result is obtained largely by small reflecting mirrors. Its efficiency must of necessity be low, and it is used only for emergencies. Periscopes are also used in the trenches. Some are scientifically manufactured; others are home-made, so that by the use of several mirrors, a soldier can look over the top of his trench, without exposing his head.

Formerly, range-finders of various patterns were used, principally in land fortifications. They are now adapted to battleship and field-fighting. The current type is horizontal. Range-finders 30 to 40 ft. long are placed on battleships. The underlying principle for all types is the relation between the sides and angles of a triangle. The objective lenses of a modern range-finder are at the extreme end of the tube. By a complicated system of prisms and reflectors, the observer looks through a single eye-piece, placed at the centre. A turn of the screw brings the distant object into coincidence or focus. The base of the triangle is the length of the range-finder, or to be more exact, the distance between the objectives. When the focus is obtained, it is easy to determine the angle formed by the base with an imaginary line extending to the distant ship, hill, fort, or trench. The problem is therefore substantially that of measuring the sides of a triangle, with a known base and adjacent angles. A dial at the side records the distance in yards. There are also small range-finders, light and portable. Thousands of these finders are used for artillery, navigation, and by infantry in the field.

No observation aeroplane is complete without a photographic camera and lens. Such a lens must be very 'fast,' which means that it must allow the entrance of a great deal of light, so that exposures may be made with great speed. Since aeroplanes have acquired such importance, new lenses are being worked out. The development is constantly going on, and remarkable results may be expected. The observers are not necessarily technical photographers. Traveling at a rate of more than a hundred miles an hour, they 'snap' the enemy's territory, then rush back to the base where the films or plates are immediately developed. These show to a trained observer the enemy positions pictured beyond dispute. By comparing one day's or one hour's observations with another, changes are instantly detected. This light spot in the

*Address delivered before the Rotary Club of San Francisco, June 18, 1918.

†Manager, Bausch & Lomb Optical Co. of California, San Francisco.

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negative shows a new trench; that dark spot a new battery. With such photographs, no surprise in the older sense, is possible. Accurate photographs from day to day, sometimes from hour to hour, lie before the eyes of the commanding officers and even the slightest change is visible and legible to the expert. In case quickness of results is imperative, the film or plate is developed immediately, and the negative placed in a stereopticon and thrown upon the screen. The officers sitting around the screen with the previous photographs before them, can note the changes at once.

Telescopic gunsights are optical instruments of the highest precision and are used by the field artillery, where the target is visible. They are of great value in effective firing.

As we all know in civil life greater attention is bestowed on the care of the eyes nowadays than formerly. Fitting glasses has become a recognized profession. The optometrist has come to stay. In the army, particular attention is now given the care of the eyes. It is recognized that few eyes are perfect, but that many defects can be remedied by proper eye-glasses. The War Department is arranging for a force of men skilled in the optical industry to assist our boys in the field. This is coming to be an important feature of the modern army; for ophthalmic correction not only increases the efficiency of the troops in the field, but adds materially to the available forces by admitting men who would formerly have been rejected because of defective eyesight.

We have all admired and wondered at the health record of the Army and Navy. Typhoid fever has practically disappeared and other contagious and infectious diseases have been reduced to a minimum by the marvelous achievements of Surgeon-General Gorgas and men of that distinguished stamp. For a century the fight against infection and disease was nearly at a standstill. The development of the microscope made possible the conquests of bacteriology, for the microscope is the handmaiden of bacteriology. Today the battle against disease is fiercer than the battles in Flanders; the issues are as broad as the world; and mankind is winning against its deadly foes of communicable disease. The microscope, therefore, is one of our most powerful allies, as, alas! it is also an ally of our hated and powerful enemy. Microscopes are used in great numbers by the medical and sanitation corps, and the lives they indirectly save cannot be estimated. They are a priceless adjunct to a modern government in war.

Searchlight-mirrors are among the highest of optical products. They are precisely calculated and accurately ground. No battleship, no fortification, no city attacked at night by aeroplanes, could make an effective offense or defense without searchlights. The efficiency of the searchlight depends in a great measure upon the mirror. The mirrors are made as large as six feet in diameter, and may contain over half a ton of glass.

These facts may justify calling this an Optical War. It is certain that optical products play an important part in modern warfare, and without them, the military clock would be turned back a hundred years. By one of those curious unexplainable negligences on the part of the civilized nations, the optical centre of the world at the opening of this War, was at Jena, Germany. The best optical glass was made there; the most accurate optical instruments were produced there; the leading optical scientists lived there. The optical industry, like the aniline-dye industry and so many others, had drifted unchallanged into the hands of Germany. At the same time, there were high-grade optical instruments produced in most of the allied countries, including the United States. The loss of the celebrated optical glass made at Jena was at first a severe deprivation. The mathematical calculations for the curves of the highest grade of lenses were based upon the refractive powers of the Jena glass. For a time it seemed as if the world could not get along without the Jena glass. In America, however, optical concerns, with the co-operation of the Government, have solved the problem as successfully as others have been solved. We now produce optical glass of high quality and in quantities sufficient to meet present demands, though slowly and with inevitable and provoking delays. The gratifying, significant, and strategic point is that it is being done successfully, and in the future we shall be as independent of Germany optically as we shall be politically, theologically, industrially, and commercially. We are beating them, thank God, all along the line.

THE DIONIC WATER-TESTER

The Dionic water-tester for determining the electrical conductivity of water is discussed by Joseph Race, bacteriologist and chemist for the city of Ottawa in a recent issue of 'The Canadian Engineer.' The tester's principal field of usefulness is in municipalities where the electrical conductivity of the city water-supply differs considerably from that of the ground-waters of the district. In such cases the tester can be used on water appearing at the surface whose origin is doubtful. If its electrical conductivity corresponds with that of the city supply, the water probably comes from some leak in the pipes, while if the water has about the same conductivity as the other ground-water of the district, it probably is ground-water, and expensive digging to find leaks in the water-pipes may be avoided. This method sometimes fails when the water from a leak travels a long distance before coming to the surface, in the meantime dissolving enough mineral matter to change materially its chemical composition and, consequently, its conductivity, but such failures occur only occasionally.

A pneumatic caulking machine that will do the work of 10 men is being used at the shipyard of the G. M. Standifer Construction Corporation at Vancouver, Washington. The machine is driven by compressed air like a riveting hammer. Its action is similar to that of a sewing machine. The oakum is received in a woven state and is fed to the machine in hanks. The machine travels on three small wheels. The oakum is twisted automatically as it is driven into the seams. Increased speed and reduced cost as compared with hand-caulking are obtained.

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The Work of the United States Shipping Board*

By EDWARD N. HURLEY

On July 1, 1916, we had no tonnage worthy of the name engaged in over-seas trade. It is true that we had under the American flag a total dead-weight tonnage on that date of 2,412,381 tons, but approximately 80% of this tonnage was engaged in coastwise and Great Lakes trade. By June 1, 1918, we had increased the American-built ships to over 3,500,000 dead-weight tons. In the eleven months from July 1, 1917, to June 1, 1918, we constructed in American shipyards a tonnage equal to the total output of American yards during the entire previous four years. We have also added 118 German and Austrian vessels, with a total dead-weight tonnage of 730,176. We have requisitioned from the Dutch under the order of the President, 86 vessels with a total dead-weight tonnage of 526,532. In addition we have chartered from neutral countries 215 vessels with a total dead-weight tonnage of 953,661. This tonnage together with the vessels that we have been obliged to leave in the coastwise and Great Lakes trade, gives us more than 1400 ships with an approximate total dead-weight tonnage of 7,000,000 tons now under the control of the U. S. Shipping Board.

Since January of the present year, when our new quantity production of ships may be said to have begun, we have steadily increased our monthly output until in May we constructed 260,000 tons, making a total for the first five months of this year of 118 steel ships and 805,000 dead-weight tons. We delivered in these five months 336,900 tons of shipping more than was built in American shipyards in 1915 and 1916. I do not believe I am over-optimistic in saying that our tonnage output will continue to increase until before this year closes we will be constructing 500,000 tons per month, or at a rate of 6,000,000 tons per year.

We have today under construction 819 shipbuilding ways for wood, steel, and concrete vessels, which is twice as many ways as there are in all the rest of the shipyards of the world combined. Our program calls for the building of 1856 passenger, cargo, refrigerator, and tank ships, ranging from 5000 to 12,000 tons each, with an aggregate dead-weight tonnage of 13,000,000. We are also contracting for 200 wooden barges, 50 concrete barges, 100 concrete oil-carrying barges, and 150 steel, wood and concrete tugs of 1000 hp. for ocean and harbor service, with total dead-weight tonnage of 850,000. Exclusive of the above, we have 245 commandeered vessels, taken over from foreign and domestic owners, which are being completed by the Emergency Fleet Corporation. These will have a dead-weight tonnage of 1,715,000. This makes a total of 2101 vessels, exclusive of tugs and barges, that will be put on the seas by the Emergency Fleet Corporation, with an aggregate dead-weight tonnage of 14,715,000.

American workmen have made the expansion of recent months possible and they will make possible the successful conclusion of the whole program. On July 1, 1917, there were in the United States not quite 45,000 men engaged in the shipbuilding yards. Today we have a force of 300,000 men in the yards, and 250,000 men engaged in allied trades. It is likely that by 1920 we shall have nearly 1,000,000 men working on American merchantships and their equipment.

As I have said, we have a total of 819 shipways in the United States. Of these 819, a total of 751, of which all except 90 are completed, are being used by the Emergency Fleet Corporation for building merchant-ships. When all our shipyards are thoroughly organized, and our fabricating plants working at full speed, and our employees are thoroughly trained in the art of ship construction, it is estimated that we can construct on each way more than three ships per year. In 1919 the average tonnage of steel, wood, and concrete ships on each way should be about 6000 tons. If we are using 751 ways on cargo-ships, and can build three ships per year per way we should construct in one year 13,518,000 tons.

The U. S. Shipping Board is not only the greatest shipbuilder in the world, but is also the greatest ship operator. The operating side is called the Division of Operation, under the management of Edward F. Carry, Director of Operations. Its function is to see that the ships in the service are well-managed and that rates are properly adjusted. The shortage in the world's tonnage and other causes brought about high ocean freight-rates. These high rates have been felt in the rising prices of all sea-borne commodities. One of the most important phases of the work of the Division of Operation has been to lower rates as much as has been possible. One result of this reduction has been to make it possible for our allies to receive necessary munitions and supplies at less cost.

The Shipping Control Committee, composed of P. A. S. Franklin, chairman, H. H. Raymond, and Sir Connop Guthrie, was appointed in the early part of February 1918, jointly by the Secretary of War and the U. S. Shipping Board. Since its appointment the Committee has directed the movement of all supplies destined for the troops overseas. It has also operated vessels under requisition of the Board and has chartered neutral shipping to carry essential raw materials to manufacturers in the United States and the various commodities needed here and abroad. Nitrates have been brought from Chile, manganese from Brazil, chrome from New Caledonia, hides and wool from the Argentine, sugar from the West

*Abstract of address delivered at Notre Dame University.

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Indies and Porto Rico, and various other commodities from all parts of the world. The Committee has also supplied vessels to take care of the food situation in Belgium.

If in 1919 and 1920 we have the passenger and cargo tonnage we have planned, we will be in a position to establish a weekly passenger-service between New York and Rio de Janeiro, Montevideo, Buenos Aires, and Caracas on the east coast, and weekly service between ports in Colombia, Ecuador, Peru, and Chile, on the western coast. We now have two fast passenger steamers plying between New York and Valparaiso. These are the first to carry the American flag on that route. They have reduced the time between these two important cities from 27 to 18 days.

On the Pacific we must provide sufficient tonnage to meet Russia's requirements. That country has many products which we need. These articles can be moved in bottoms controlled by us at fair freight-rates and this will be most helpful to the expansion of Russia's trade. China also has many commodities which we require, and should have the ships required to move them.

Building and operating vessels is not the only work the U. S. Shipping Board is doing to create and develop a merchant marine. A Port and Harbor Commission has been appointed. We expect to develop and organize our harbors so that the merchant marine we are creating will have adequate facilities for dispatching and receiving cargoes. With development of drydocks and bunkering and repair facilities, we shall have the most modern improvements, which will enable us, in cooperation with the railroads, to load and unload ships quickly, thereby preventing delays of ships in port.

RESISTANCE OF HARDWOODS TO INJECTION WITH CREOSOTE

Bulletin No. 606 of the U. S. Department of Agriculture on 'Relative Resistance of Various Hardwoods to Injection with Creosote,' by Clyde H. Teesdale and J. D. MacLean, has recently been issued. The results of experiments on 25 representative species of hardwood are recorded and the following conclusions given:

There are several important factors other than the wood-structure that, in commercial work, influence the absorption and penetration of preservative. Some of these are the natural variability of the wood, even in the same species, the moisture content when treated, the method of seasoning and treatment adopted, and the character of the preservative used. In order to study the effect of the various elements of wood structure on the penetration of creosote, it was necessary, so far as possible, to eliminate these other factors. The following conclusions, which are based only on structural considerations, should not be applied to commercial practice, such as the grouping of timber for treatment,* without considering the other factors that are involved.

*Some of the other factors affecting the treatment are discussed in Forest Service Bulletin 118, 'Prolonging the Life of Cross-Ties.'

1. The most important of the structural factors affecting the penetration of the hardwoods is the condition of the vessels in the wood. When the vessels are open, it is comparatively easy to secure good penetration. If the vessels are closed by tyloses or gummy substances, the permeability is reduced considerably.

2. Next in importance is the ability of the wood prosenchyma (fibres, etc.) to absorb creosote. In some species having numerous and well-developed tyloses in the pores (hickory, for example), it was possible to obtain deep penetration on account of the comparative ease with which the wood prosenchyma could be treated. The penetrability of this part of the wood structure is therefore of great importance in species having the vessels closed by tyloses or other material. The wood prosenchyma in the sapwood took treatment much more easily than that in the heartwood, probably because the heartwood contained infiltrating substances in the cell-walls which tended to make the wood substance less permeable. Woods that were penetrated in both the vessels and wood prosenchyma generally showed the heavier absorption and deeper penetration. Those species which took irregular absorptions were found to possess unusual structural characteristics, such as an irregular distribution of tyloses, interlaced fibres, or cross-grained structure. Even in species of similar structure the manner of taking treatment may vary widely. This is illustrated in the treatment of hickory and white oak. Both of these woods are ring-porous and the vessels are closed by abundant tyloses. Hickory, however, took a fairly good treatment, whereas white oak was practically impermeable. The variation in the permeability of red-heart and white-heart beech is also an example of the different manner in which woods of similar structure may take treatment.

3. Penetration and absorption of the preservative is much less uniform in woods of the diffuse-porous group than in the ring-porous, probably because the tyloses in the vessels, and the gums and infiltrating substances are less uniformly distributed in diffuse-porous woods. In most species treated little or no penetration of the preservative occurred in the medullary rays and other parenchyma cells.

The latent heat of steam of standard pressure and temperature is a fundamental constant, the value of which has long been less satisfactorily known than was desirable. The values given in Kaye's and Laly's 'Physical and Chemical Constants' differ appreciably, ranging from the 537 calories of Regnault obtained in 1847 to the 540 calories found by Joly in 1805. A new determination is described in a paper by T. Carlton-Sutton, published in a recent issue of the Proceedings of the Royal Society. The plan of the experiment consisted in weighing the quantity of steam condensed upon a bulb, both when empty and when filled with water. From the two observations the latent heat can be deduced, the value found being 538.88 mean calories. It is claimed that this figure is correct to the fourth significant figure.—'Engineering.'

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The Use of Powdered Coal*

By W. G. WILCOX

Power and raw material are the two factors that make up the balanced ration of industry. No matter how great our national resources, they will be of little value unless the power necessary for transportation, manufacturing, and fabrication is available. The greatest source of power is obtained through the combustion of fuels. Shortage of fuel at this time is so alarming as to call for the most careful consideration. The production scarcely equals the consumption. Concomitantly with the greatest demand for coal we have ever experienced we find the great natural gas-field of West Virginia failing alarmingly. This brings into the list of coal-consumers new users that were formerly dependent upon natural gas. At the same time fuel-oil is steadily becoming harder to obtain and almost prohibitive in cost. The oil-fired forge-furnaces of the East and the copper-reverberatories and cement-kilns of western Texas, Arizona, and Utah, the potash-producers of Nebraska, and the apartment-houses of Seattle are seeking supplies of coal. This means another new demand and a further burden on railroad transportation. As the railroads must have more coal in order to haul more coal the seriousness of the situation increases geometrically.

For this exigency there are three possible solutions:

1. Stimulation of the production and transportation of fuel.

2. Development of efficient methods for utilizing low-grade fuels hitherto practically unused.

3. Combustion of the fuel in so much more efficient a manner as to make the amount available adequate for all needs.

At best there does seem little reason to expect a great increase in production. Our largest opportunity for escape from the dilemma lies in the efficient combustion of both low-grade and high-grade fuels. It is far wiser to curtail avoidable losses than to compensate for them by increasing the supply. It is pre-eminently the patriotic and professional duty of the chemist and the engineer to work for the more efficient utilization of fuel. Among the more efficient methods of combustion is the use of powdered fuel. Assuming a good design of furnace and flue, and the proper draft, the essentials of good combustion for coal are:

1. Complete oxidation of all the combustible matter in the coal to avoid loss of combustibles in the ash and up the stack The loss of unburned carbon will vary with different types of fuel, with different types of ash, and with the percentage of ash in the coal. It will also vary with the type of stoker used and the boiler-load carried. In hand-firing it will vary with the skill of the fireman; and in producer-operation it will vary according to the quality of the coal, the type of the producer, and the operating conditions.

Using an Illinois coal of the following analysis:

	%
Sulphur	5½
Volatile matter	34
Fixed carbon	42
Ash	18½

one of the large users in the Middle West records the following losses in ash:

	Actual per cent of coal lost
Over-feed stokers, 25% unburned carbon in the ash	4.6
Chain-grate stokers, 35% unburned carbon in the ash	6.5
Hand-fired, 35% upward unburned carbon in the ash	6.5 and upward

This particular consumer has two different types of stokers and also does a large amount of hand-firing. His consumption is over 100 carloads of coal per day; operations are under the direction of skilled technical men.

In producer-operation, using a good-grade coal, 20% of unburned carbon in the ash is the minimum figure. Under bad conditions, when poor fine wet coal was used, and with variable steam-pressure, as high as 55% unburned carbon will be found in the ash even with a first-class modern producer.

With any type of stoker or producer the loss due to unburned carbon increases with the ash-content. Certain coals, although of high heating value, present enormous difficulties to efficient operation when put through a producer, or when burned on grates or on stokers. A case in point is a coal from south-western Virginia. This develops over 14,000 B.t.u. and contains under 8% ash; it shows fine laminations of pure calcite in amount sufficient to flux the other constituents of the ash and cause continuous trouble from clinkering.

Another case is a Colorado coal having the following proximate analysis:

	%
Ash	6.66
Volatile matter	43.76
Fixed carbon	49.58
Sulphur	0.93
B.t.u.	12,886

The ash melts, runs down the grates and freezes there, while the coal itself disintegrates, and chokes the fire.

*Paper read before the Western New York section of the American Chemical Society, May 31, 1918, by the Advisory Engineer to the Powdered Coal Engineering & Equipment Company, of Chicago.

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2. Control of combustible and air. This is absolutely essential if we are to secure the maximum flame-temperature with a correspondingly increased rapidity of heat-transfer. The more rapid the transfer of heat in the furnace or boiler the higher the capacity of the furnace, and in general the greater the efficiency.

3. Control of flame-length. In order to maintain the conditions that the design of the furnace, the operation, or the metallurgical process, requires, it is essential that the length of the flame be under control. An example is found in a recent development in firing copper reverberatory furnaces. For a long time it has been the practice to fire such furnaces with an insufficient amount of air, admitting the amount required to complete combustion through ports in the side of the reverberatory. It has been found that if the number of oil-burners is increased, and the mixture of oil and air so adjusted as to give complete combustion with a short hot flame, the capacity of the furnace is increased in some cases as much as 50%, while the fuel ratio is greatly improved. This is also true of reverberatories fired with powdered coal. In this particular operation it has been found that a short hot flame leads to more efficient operation and increased capacity; but there are other processes in which the reverse is true.

In changing the fuel, for example, in turning from the hand-firing of coal to powdered-coal combustion, the economies are usually far greater than those that can be figured from the known losses. The increase in capacity is usually so great that it can only be attributed to the increased efficiency of the furnace. This may follow from the fact that the operator is enabled to maintain the flame-length and type of combustion for which that particular furnace is suited.

4. The method of combustion that is to be most efficient must possess flexibility in capacity. Flexibility in combustion means rapid response. Only in this way can a cold furnace be brought to heat quickly or a stand-by boiler come up to peak-load rapidly. This makes for efficiency because it reduces the fuel consumption during the stand-by period. Many operations also require variation in heat input at different stages; in order to secure the highest efficiency under these conditions, extreme flexibility as to 'combustion load' is demanded.

5. Control of the nature of the cumbustion. In many operations it is not only necessary to heat uniformly, quickly, and efficiently, but it is equally important to maintain a certain chemical condition in the atmosphere of the furnace. This may be oxidizing, reducing, or neutral. In any case the control of combustion should be such that the desired condition may be maintained within close limits; failure to do so means a waste of fuel. Maintaining an oxidizing condition without ability to control it within close limits will result in an excess of air, which will lower the flame-temperature, lessen the output, lower the furnace efficiency, and reduce the fuel-efficiency. Likewise a reducing condition, unless maintained within close limits, means that fuel is needlessly wasted. If the operation demand a neutral condition, there may be some loss due to the spoiling of the product, unless it be possible to maintain the neutral condition exactly.

6. One-stage combustion. The best example of two-stage combustion is the producer, which in many of its applications affords an over-all efficiency that is considerably higher than may be obtained by other methods. Nevertheless we should realize that in the process for making producer-gas there is an inherent loss of at least 20% because of the inability to gasify without forming a certain percentage of CO_2, due to heat-losses at the producer and losses in sensible heat from the gas between the producer and the point at which it is used.

There is another serious objection to two-stage combustion. When combustion is completed, the final flame-temperature is lower than in a one-stage process. Unless we resort to such devices as the recuperator or regenerator, high temperatures cannot be reached. Furthermore a two-stage combustion results in 'cracking' some of the most valuable constituents of the coal, with the formation of smoke in the furnace and soot in the producer. This has been shown by Kreisinger, Augustine, and Ovitz, in Bulletin No. 135 of the U. S. Bureau of Mines.

Having considered the essentials of combustion, we can estimate the value of powdered coal as a fuel. In the same way we can ascertain also the conditions demanded for success in the combustion of pulverized fuel.

The simplest view of the combustion of coal is to regard it as a reaction between fuel and oxygen. It is a heterogeneous system; consequently the velocity of the reaction and its completeness will depend upon the surface exposed by the solid, the pressure of the reacting gas, and the intimacy of the mixture. By grinding an inch cube of coal so fine that 85% will pass a 200-mesh screen, we have increased the surface exposure from six square inches to approximately 1800 sq. in. Thus we have increased the velocity of combustion 300-fold. By doing so, we have changed the characteristics of the fuel. We now have a fuel relatively 300 times more active than the inch cube of coal, a new type of fuel that has in it inherent possibilities not to be found in lump or slack fuel. By increasing the surface exposure 300-fold, we have speeded combustion proportionately. This carries with it a further effect. The increase in rapidity of combustion also increases the rapidity of heat evolution, and consequently quickly raises the temperature of the rest of the material. This rise of temperature, which is much more rapid than in the normal combustion of coal, will double the velocity of combustion for each rise of 10°C. The increased rapidity due to greater surface exposure and that due to temperature rise are superimposed so that a pulverized fuel affords a combustion that is hundreds of times faster than when burning lump-coal.

Having a finely-divided fuel it is possible to form a mixture of fuel and air so intimate that each small particle of coal is surrounded by the proper amount of air. In this condition, by maintaining the proper velocity of

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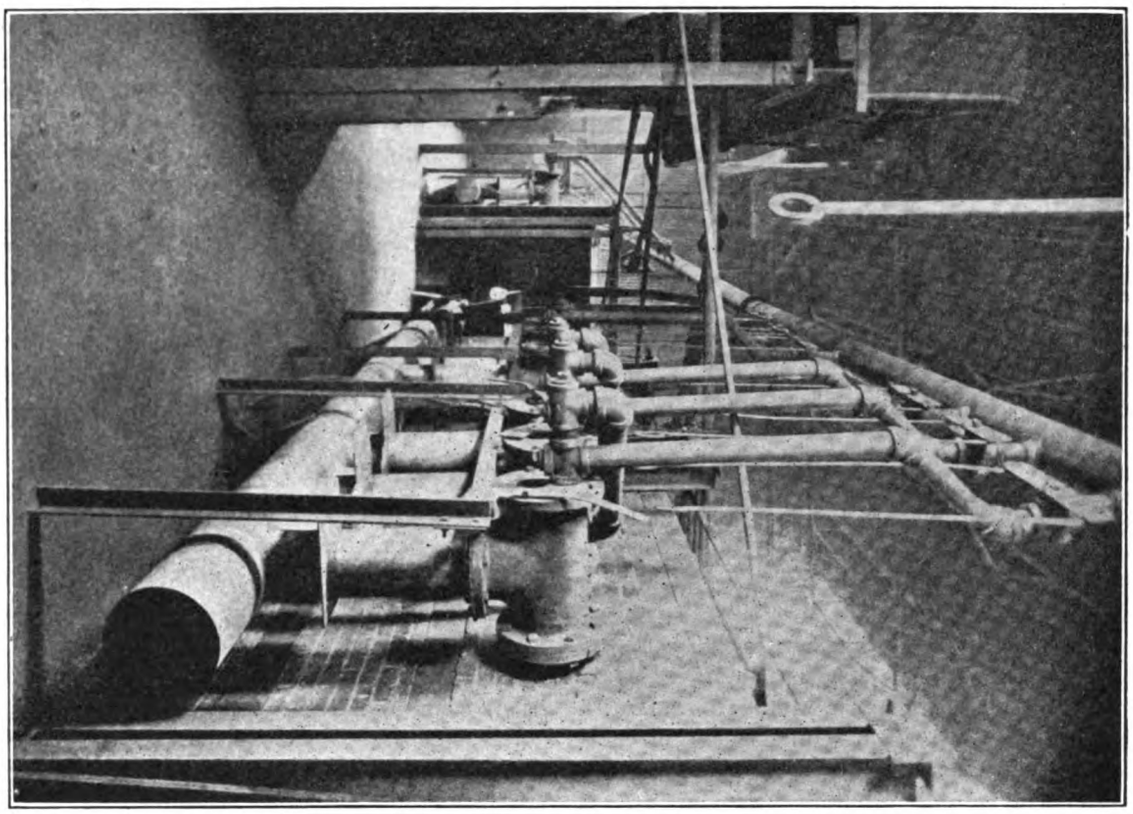
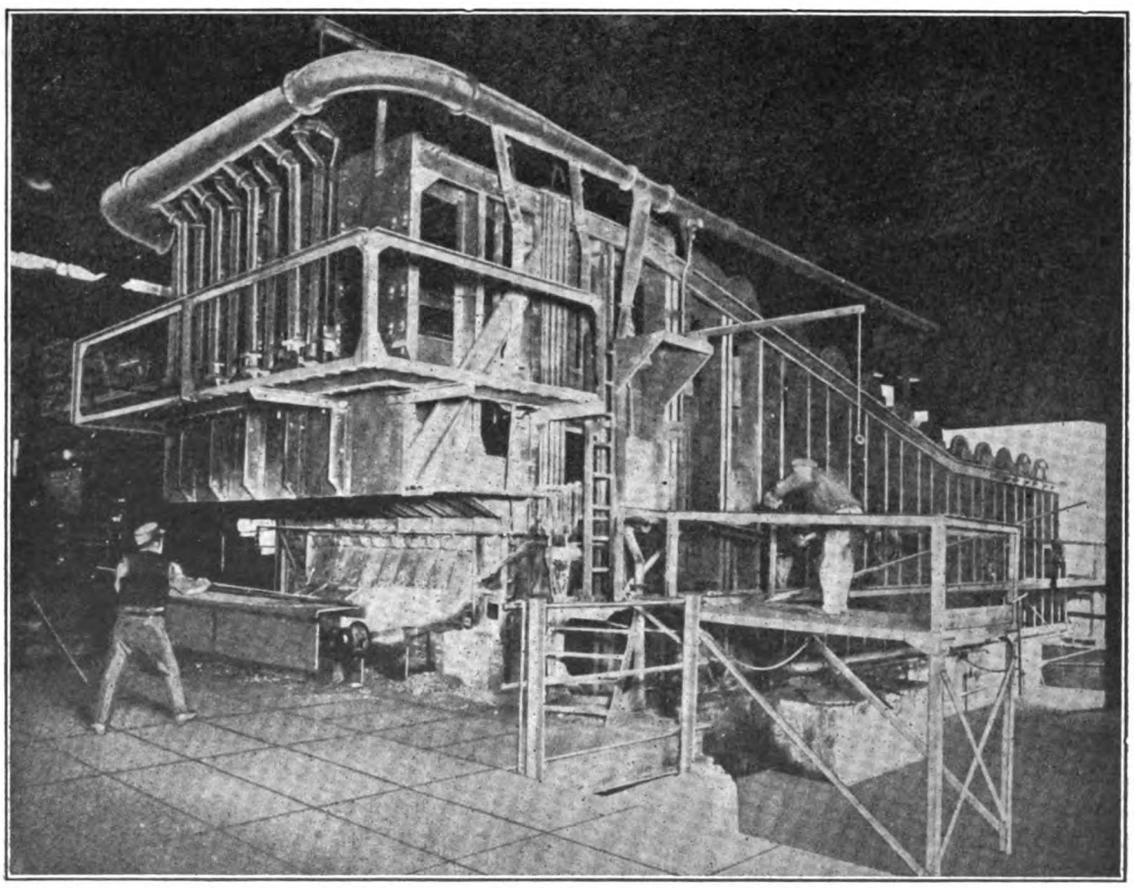


PLATE-HEATING FURNACE SHOWING POWDERED-COAL FEED-PIPE AND CONNECTIONS TO BURNERS



DISCHARGE END OF CONTINUOUS-BILLET HEATING-FURNACE

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the air-current, the fuel can be carried into the furnace in suspension and there burned completely, efficiently, and rapidly.

It is, of course, a simple matter to mechanically control the amount of powdered coal delivered to the furnace in a given time. It is also possible to control the amount of air delivered with the coal. If, then, we deliver to the furnace an intimate mixture of air and powdered coal, and control the amount of coal-dust and air delivered, we have the prime essentials. The degree to which they are attained depends entirely upon how carefully we study the characteristics of the fuel before and during combustion.

The amount of coal-dust delivered can be controlled simply and positively by using a screw-feeder operated at variable speed. It is also a simple matter to control the volume of air admitted with the fuel; but the highest efficiency possible with this type of fuel will not be obtained unless we work out a correct way in which to mix a finely divided solid with the air.

A study of the methods for making such a mixture immediately shows that the methods commonly used in making a uniform mixture of two miscible liquids or a uniform solution of a solid in a liquid, or the methods used in mixing finely-ground solids are not only useless in this case, but will actually separate the coal-dust from the air. Ordinary mixing is done by agitation; this agitation is usually accomplished by baffling, stirring, shaking, or similar devices. When, however, such methods are applied to a mixture of gas and finely divided solid, the solid tends to separate by reason of its higher specific gravity. This, in fact, is the principle of the well-known cyclone dust-collector. Any mixing device that produces such agitation of the dust and air as to give a centrifugal effect will tend to separate, not mix, the air and the dust.

The importance of mixing the coal-dust and air intimately cannot be exaggerated. The rapidity of combustion is a direct measure of the intimacy of the mixture. This is well illustrated by comparing the ordinary gas-flame with the flame obtained in the Bone combustion system, which consists in forcing the proper proportion of air and gas through a diaphragm having numerous interstices. When this mixture is ignited on the other side of the diaphragm, it produces a film of flame.

The poorer the mixing, the longer the flame. The flame simply outlines the area in which combustion is taking place and the length of the flame is a measure of the time element necessary to accomplish combustion. This time element—other conditions being equal—is absolutely a function of the intimacy of mixture, as was noted by Breckenridge ten years ago, when in Bulletin No.325 of the U. S. Geological Survey, he stated:

"The conclusion is reached that the velocity of combustion decreases enormously from the surface of the fire to the rear of the combustion-chamber, where it is relatively very small, the practical application is that little is to be gained by adding further length of smooth combustion-chamber, which would be commercially as poor an investment of capital, as to add to the length of a Corliss engine-cylinder and stroke; we must resort to thorough mixing."

Just as in the past there has been a remarkable failure to realize the necessity for intimately mixing air and coal-dust, so there has been insufficient consideration of the characteristics of this fuel when burning. Powdered coal has the characteristics of a rich fuel of somewhat higher kindling temperature than producer-gas, natural gas, or fuel-oil. To illustrate the fact that it is a rich fuel, we can compare the available B.t.u. in a cubic foot of a correctly proportioned mixture of powdered coal and air and the available B.t.u. in a cubic foot of correctly proportioned mixture of pure methane and air. Take a Pittsburgh coal (heating value 14,157 B.t.u.) of the following analysis:

	%
Volatile	35.4
Fixed carbon	58.5
Ash	6.1

We find that a cubic foot of a correctly proportioned mixture of coal-dust and air has available 107 B.t.u., while a mixture of pure methane and the proper amount of air has available per cubic foot, 62.3 B.t.u.

The rapidity of combustion and the completeness of combustion of a mixture of coal-dust and air depend upon a number of factors: for example, they are dependent upon the velocity and pressure at which it is passed into the combustion-chamber. If the velocity of the incoming stream of powdered coal and air is above the velocity of flame propagation, combustion will not take place until the mixture has slowed down to a point that it does not exceed the velocity of flame propagation. When powdered coal is fired at high pressure and high velocity, combustion frequently does not begin until a point four to six feet from the mouth of the burner. A similar example is found in the plumber's blow-torch when too much air is used, or in the Bunsen burner when the gas-pressure is too high. High-pressure firing not only slows down combustion, thus increasing the size of the chamber necessary, but has a destructive action on the furnace. It has been well established that high velocities in the combustion-chamber or a blow-torch effect due to firing at high pressure (whether oil or gas be used as a fuel) are always destructive of the brickwork. This action is increased in high-pressure firing of powdered coal, since, in addition to the erosional effect of gases at high temperature traveling at high velocity, there is a fluxing action by the melted ash. Furthermore, the slagged ash will be carried along mechanically, leading to further furnace troubles. In one case this resulted in a deposit of slag on the mud-drum of a vertical waste-heat boiler at the end of a long reverberatory furnace. Slowing the velocity not only hastens combustion, but makes it possible to eliminate much of the slag. When the velocity is low the coalesced particles of slagged ash are either larger than will be carried by the velocity of the gas or this condition is so nearly approached that a slight change in direction of the flame will result in dropping out the slag. Thus, in addition to being correct com-

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bustion and necessary in order to avoid excessive furnace-maintenance costs, low-velocity combustion, by a slight change in flame direction, permits the dropping out of a large quantity of the slagged ash in the early part of combustion, where it can be removed and will not interfere seriously with efficient metallurgical operations.

The velocity of combustion is not only dependent upon the fineness of the particles of coal, the intimacy of the mixture, and the velocity of the stream of combustible and air, but is affected by the temperature of the combustion-chamber. The kindling temperature of a mixture of powdered coal and air is higher than that of either oil or gas; consequently for successful and complete combustion, it is necessary that the combustion-chamber be maintained above a certain minimum temperature and that the combustion be practically completed before the products of combustion pass over the heat-absorbing surface. Just as you can extinguish a gas flame by passing over it a piece of wire-gauze, so the effect of a chilling surface will be even more marked with this combustible material than with burning gas, since the particle of coal is infinitely larger than a molecule of gas and the kindling temperature is also higher. This has a direct application to the successful firing of locomotive boilers, water-tube boilers, and return-tubular boilers. If the combustion of powdered coal be not sufficiently developed before the flame enters the tubes of the locomotive boiler, combustion will be checked and coked coal settle out in the tubes. If, on the other hand, combustion be sufficiently developed before the flame is brought in contact with the heat-absorbing surface, complete combustion and high efficiency are obtained.

A study of the flame developed at a low pressure by an intimate mixture of coal-dust and air shows that combustion is extremely rapid. In a copper-reverberatory furnace at Florence, Colorado, where this type of combustion is used, coal burned at the rate of approximately one ton an hour develops a flame that vanishes within six feet of the burner, combustion being complete at that point. Let us translate this into terms of natural gas, in which case the fuel consumption would be approximately 26,000 cu. ft. per hour or 433 cu. ft. per minute. You can picture to yourself this quantity of gas being burned at low pressure and developing a flame only six feet long. Samples of gas taken in the flame show a content of CO_2 as high as 16% only five feet from the mouth of the burner. This will give an example of the rapidity with which combustion can be obtained and the possibilities of shortening the flame. With proper equipment is is equally practicable to lengthen the flame until it will spindle out a distance as great as 100 or 120 ft. However, with an intimate mixture under control, this must be done by supplying insufficient air. Under such conditions combustion is incomplete and the flame spindles out because combustion continues to develop throughout the length of the furnace as air-leakage supplies additional oxygen. This is proof of the statement that the length of flame is an actual measure of efficiency of mixing and the adjustment of the fuel-air ratio.

Thus, it is seen that we have changed entirely the characteristics of coal as commonly known. Powdered coal is a fuel of extreme flexibility, in that the amount burned can be varied within wide limits. It is a fuel that develops a flame whose length can be adjusted. The character of the flame can be altered to suit the metallurgical operation. In short, the basic fuel, coal, has acquired the characteristics of oil or gas, but with better and closer control. Furthermore, the possibilities of this fuel are not only capable of realization, but are actually being utilized in commercial practice today. To the flame characteristics of a rich fuel, developing a flame like oil or gas, is added a degree of control not yet obtainable in burning either oil or gas. This statement is made advisedly. The possibilities of such combustion for the improvement of processes, for fuel economy, for increasing output, through its ease of control and elimination of heavy labor, are realized by few. Owing to the attitude of labor and the scarcity of skilled operatives, it is far more difficult than ever before to secure high efficiency and good operation in hand-firing, stoker-firing, or in producers, in short, whenever such efficiency depends upon constant watchfulness and hot, heavy, disagreeable work. For these conditions powdered coal substitutes an ease of control such that the equipment can be handled by an old man or a boy, while it is so simple that a man of ordinary intelligence can soon be taught all that is necessary for good efficiency in operation. The possibilities of such control in the place of present-day combustion methods, which permit high efficiency only by the most strenuous effort, through substituting for these a type of combustion whereby high efficiency is easily obtained, are certainly of great importance to us at the present time.

To those who are in touch with many diversified chemical industries, the possibility of maintaining and regulating heating conditions that are oxidizing, reducing, or neutral at will, conditions that once adjusted will remain constant—barring mechanical or electrical interruptions—will undoubtedly suggest many new economies and betterments.

Materials for one mile of first and second-line trenches and communication-trenches on the British front, according to C. G. Martin of the Royal Engineers, include the following: 900 miles of barbed wire for entanglements, weighing 110 tons; 12,000 standards 6 ft. high; 12,000 small pickets; 6,250,000 sand-bags, weighing 1000 tons; 36,000 sq. ft. corrugated iron; 1,125,000 ft. B.M. lumber.

Patents issued by the United States during the year ended December 31, 1917, numbered 41,069, of which 39,225 were to citizens of the United States. The total number of patents issued by the U. S. Patent Office to December 31, 1916 was 1,220,345. The total number in all foreign countries was 2,650,035, Great Britain leading with 513,388.

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Increased Service From Highways by Means of Return-Loads Bureaus

The Council of National Defense, through its Highways Transport Committee and various State and local organizations is encouraging more efficient use of the highways of the country as a means of affording merchants and manufacturers relief from railroad embargoes and delays due to freight congestion. The system used, namely, that of return-loads bureaus, is already in successful operation in Connecticut and is being extended throughout the country. The purpose is to take some of the burden of the short haul from the railroads by using motor trucks. Considerable quantities of merchandise and materials of all kinds are now being carried by trucks operated by private concerns in their own businesses and by motor express and haulage companies. Usually, however, these trucks, after delivering a load, return empty, whereas there are shippers that would be glad to avail themselves of the opportunity to send a load back on such a truck if they knew it was returning empty. On the other hand, the truck-owner would be equally glad to secure a return-load because the charge made for hauling it would materially reduce his own haulage-cost.

The logical agency for bringing the shipper and the truck-owner together is the local business men's organization in each locality. The officers of such organizations are acquainted with the manufacturers and merchants in their respective communities, they know the present difficulties of shipping and they have the facilities for putting the shipper in communication with the truck-owner. The method of doing this is by the establishment of a return-loads bureau, an information department that acts as a clearing-house for this particular purpose. Once started, the work of such a bureau can be handled at relatively small expense. If necessary or desirable, a small charge can be made to the truck-owner or the shipper for the service to cover the expense of starting and maintaining the bureau.

Much short-haul freight can be carried on the highways by motor trucks. It can be received at the door of the shipper and delivered at the door of the consignee, entailing only two handlings. It can be delivered the same day it is shipped, whereas the same shipment by rail might require several days. Furthermore, the shipment can go by motor when a freight and express embargo precludes shipment by rail at all. The practicability and dependability of motor-truck haulage not only within cities, but between neighboring cities have been demonstrated fully. Hundreds of local and intercity motor-express lines are in successful operation in widely scattered parts of the country. The return-loads bureau system is being used in England, where it is now considered unpatriotic to run a truck without a load. Manchester and all the surrounding cities have their return-load bureaus and have reciprocal arrangements whereby they exchange information regarding available trucks and loads.

A return-loads bureau can be established without creating any legal liability to the shipper or assuming any other responsibility. The function pure and simple is to tell the shipper where and when a truck can be obtained to haul his goods and to tell the truck-owner where a load can be obtained. In England, when such a relationship has been established between the shipper and the truck-owner, an arrangement is often made between them for regular service, and they do not need to call for further assistance, thus lightening the work to be performed by the bureau. The shipper and the truck-operator make their own agreement as to the rate to be paid for haulage, liability of the truck-owner or driver for the safety of the goods in transit, and so forth. It is expected, however, that the bureau will exercise reasonable judgment and precaution, inquiring into the reliability of truck-drivers and endeavoring to correct any abuses that may arise.

In Connecticut, through the initiative of the State Council of Defense, return-loads bureaus have been established in 15 cities. The Council addressed letters to the Chambers of Commerce, inviting their co-operation in the movement. Return post-cards were mailed to motor-truck owners in the different cities. On the reverse side of the cards was a brief questionnaire to be filled out by the truck-owner stating whether or not he would carry 'back-loads' for reasonable compensation, whether he would rent his truck at full capacity or part capacity, number of trucks owned, number of hours per day or days per week the truck would be available under the return-loads plant, its capacity in tons, etc. As these cards came back, they were filed, arranged by cities and by routes out of the respective cities. This canvass showed that there were in the 15 cities more than 700 trucks of 1-ton capacity or more available for such service and that they operated over 49 main routes.

Duplicates of this master-file were furnished by the State Council of Defense to the Chamber of Commerce in each of the 15 cities, together with a map showing each return-loads bureau and all of the truck routes, numbered serially. Thus, the head of the bureau in each city knows just what trucks are available in the other cities and the routes over which they operate.

Having ascertained what trucks are available for hauling, the next move is to circularize the merchants, manufacturers, and other business enterprises in the community, telling them of the establishment of the bureau and asking them to report whenever they have goods that they wish to have hauled, either within the city or to near-by cities or villages. These reports may be made by telephone or on postal cards. Publicity should be given in all the local newspapers and in those of neigh-

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boring cities of the establishment of the bureau, so that everyone may make use of the facilities afforded.

It will be found that there are two classes of business to be handled in the bureau, regular and irregular. In many cities there are motor-express lines operating on daily schedule over regular routes and there are shippers who have regular shipments to make. Having brought these together once, further service of the bureau will be unnecessary so far as these particular persons are concerned. Then there are many companies, firms, or individuals that own trucks which they use only in their own business, but which stand idle part of the time, or which from time to time deliver a load in a neighboring city and return home empty. There are also shippers who have depended on the railroad, but in an emergency wish to make a quick shipment. It will be necessary to keep a daily record of these and cross off the truck or the shipment as soon as it is learned either that the truck has returned to its home city and is no longer available or that the shipment has been completed.

A system of daily interchange of information regarding this irregular service should be arranged with bureaus in other cities, so that a truck-operator in Sacramento, for example, that has a load to haul to Stockton can learn from the bureau at Sacramento before starting where and when he can secure a load at Stockton to take back to Sacramento. He may find that by delaying his own shipment a day or by making it a day earlier he can get a return-load, whereas otherwise he might have to return light. Shippers, therefore, should be urged to give as much advance notice as possible of shipments they wish to make.

Movement for Saving Fuel-Oil in California

The gross production of petroleum in California during 1917 was 97,800,000 bbl. Shipments both to Californian consumers and those outside the State amounted to 108,800,000 bbl., 11,000,000 bbl., mainly fuel-oil, being withdrawn from storage. While the shortage is more serious in California than in the rest of the country, consumption for the entire United States exceeded production during 1917 by about 5%. The production of oil during 1918 will probably not be much in excess of the production in 1917. It is more likely to show a decrease. The legitimate use of oil, particularly fuel-oil, is bound to increase. If measures are not taken to decrease waste, consumption during 1918 will be 10 or 15% in excess of production. The present wasteful methods of burning fuel-oil must stop.

Tests have shown that the average saving of fuel in using superheated instead of saturated steam on locomotives is 25%, without considering other possible economies of operation. The total consumption of fuel-oil in the United States is about 160,000,000 bbl. A 25% saving would mean 40,000,000 bbl. available for other uses. There are, of course, many plants where a 25% saving would either be impossible or would entail such an expense for equipment that it would not be worth while. But even a 10% saving would be 16,000,000 bbl., and would go a long way toward eliminating the present shortage.

To promote economical use of fuel-oil in California, the State office of the Federal Fuel Administration, working in conjunction with J. M. Wadsworth of the U. S. Bureau of Mines, has prepared a pledge-card which is being sent to owners and operators of boiler-plants throughout the State. A pamphlet containing general instructions on methods of saving oil fuel, expressed in non-technical language, has also been prepared by Mr. Wadsworth and may be obtained from the Fuel Administration. One side of the pledge-card contains the owner's pledge and the operator's pledge. The owner's pledge is as follows:

1. Install recording instruments; they make possible an accurate knowledge of plant operations, and will pay for themselves.
2. Institute bonus system of firing contingent on minimum CO_2 reading from flue-gas analysis.
3. Do not be misled by efficient boiler-performance into regarding your entire plant efficient. The greatest losses occur in utilization of steam and the heat of the steam should be conserved to the fullest extent by the efficient operation and selection of machinery.
4. Chart daily plant-performance.
5. The installation of feed-water heaters, economizers, and superheaters for regenerating waste heat where possible, are strongly recommended and will pay dividends.
6. The insulation of steam-piping.
7. Recovery of latent heat from exhaust steam.
8. Pre-heat air for combustion requirements.
9. Do not use boiler compounds where outside treating-plants are feasible.
10. Adopt a burner to meet your furnace requirements.
11. Determine proper temperature to heat fuel-oil for viscosity permitting maximum burner-capacity. Do not heat above this.
12. Efficient plants evaporate 14-16 pounds water (from and at 212°). Does yours? Thermal efficiency of 74-84%.
13. Recognize the value of the fuel engineer in the economical operation of your plant.
14. Study the pamphlet issued by this administration on application.

The operators pledge is as follows:

1. Watch air admission—a hazy stack ordinarily indicates more economic conditions than does a clear stack.

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2. Get CO_2 reading on flue-gas, if possible, to determine position of air and stack dampers for different operating conditions.

3. Remember forced firing means high stack-temperatures and consequent waste.

4. Systematically clean boilers and settings. No boiler is an efficient steamer when fired through sooty or scaled tubes.

5. Remember it requires 18-20 hours to heat boiler settings to their maximum temperature. Avoid unnecessary shut-downs.

6. Study pamphlet issued by this administration on application.

7. Welcome the bonus system of firing, as it puts the matter of firing on a business basis.

8. Watch steam requirements by main machinery, immense wastes are attributable to radiation, friction, and condensation in the utilization of steam.

9. Regulate the feed-water to uniformity where possible.

10. Save exhaust steam and recover the latent heat from it.

11. Note the furnace condition, if heating-surfaces are too close to the fire proper combustion is not possible.

12. Do not overheat fuel-oil. The point where the viscosity allows maximum capacity of burner is the proper point.

13. Be sure your plant records are accurate for your own protection.

14. Watch the boiler-setting for possible air-leaks.

15. Co-operate with your employer in this campaign, it means more money for both of you and is a patriotic act of conservation.

On the other side of the card is a blank to be filled out giving a description of the particular boiler-plant, including primary and auxiliary equipment, operating conditions, employees, fuel consumed, etc. Over 2000 of the cards have already been signed and returned to the Fuel Administration.

The Fuel Administration, of course, does not ask or expect the owner of a single boiler to purchase recording instruments and apparatus, the cost of which would be out of all proportion to the possible saving. But every boiler-plant owner and operator can study the waste of fuel in the operation of his plant, and take steps to prevent such waste. In a plant of say, 500-hp. capacity or more, all the measures outlined on the pledge-card will usually be found worth while, and there should be no hesitancy about adopting them.

C. N. Cross, assistant professor of mechanical engineering at Stanford University, has been retained by the Fuel Administration to visit various boiler-plants and co-operate with the owners and operators in devising means for the more efficient use of fuel-oil. While the engineers of the Fuel Administration will do their best to co-operate with plant-owners in advising them as to the best methods of saving fuel in their plants, their time is, of course, extremely limited, and it is to be hoped that owners in general will obtain expert advice from engineers in private practice.

ADOPTION OF THE METRIC SYSTEM OPPOSED IN GREAT BRITAIN

The final report to the British Parliament of the Committee on Commercial and Industrial Policy after the War contains a chapter relating to weights and measures. The 19 members of the Committee were unanimous in opposing the compulsory adoption of the metric system. Their conclusions are as follows:

"Having given very full consideration to the subject, we are unable to recommend the compulsory adoption of the metric system in this country. In our opinion, it is absolutely certain that the anticipated uniformity could not be obtained for a very long period, if ever.

"There is, further, the serious objection that if we induced the above mentioned countries to change over to the metric system, we should be surrendering to Germany the advantage which our manufacturers now enjoy over hers, both in their markets and our own.

"We are informed that even in France, which has made the metric system nominally compulsory for more than half a century, the 'pouce' (or inch) is used in textile manufacture and numerous local measures still survive.

"In referring to these considerations, we have to point out that there is no unanimity even as to the theoretical merits of the metric system as compared with our own. The practical argument that its adoption is desirable in order to secure uniformity in the markets of the world has been shown to be unfounded. We are not satisfied by any evidence which has been brought before us that trade has actually been lost to this country owing to the fact that the use of the metric system is not compulsory.

"But to attempt to make the use of the system universal and obligatory in this country would cause loss and confusion at a particularly inopportune moment, for the sake of distant and doubtful advantages. We are convinced that, so far from assisting in the re-establishment of British trade after the War, such a measure would seriously hamper it.

"As regards the educational advantages claimed for the change, we have been referred to a statement quoted by the Select Committee of 1895 that no less than one year's school time would be saved if the metric system were taught in the place of that now in use. The information which we have received does not support that statement, and even if it were well founded, it must be remembered that for at least a generation, children would have to learn both the new and the old measures and how to convert from one to the other.

"It is often popularly supposed that the introduction of the metric system would render possible the immediate sweeping away of many complicated and varying weights and measures. As we have already indicated, this belief is, in our opinion, wholly fallacious.

"We are not convinced that the metric system is, upon the whole, even theoretically superior to the British system, and we are satisfied that the practical objections to the proposed change are such as decisively to outweigh any advantages which are claimed for it."

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The Basic Principle of Concrete Mixes*

By DUFF A. ABRAMS†

It is commonly stated that concrete is composed of a mixture of cement, sand, and pebbles or crushed stones. This conception of concrete overlooks one essential element of the mixture; namely, water. An exact statement of the ingredients of concrete would be: Cement, aggregate, and water. The last-named material has not yet received proper consideration in tests of concrete or in specifications for concrete work.

Early users of concrete centred their entire attention on the quality of the cement, and practically disregarded the characteristics of the other ingredients. During the past dozen years some attention has been given to the importance of the aggregate, but it is only recently that we have learned that the water also requires consideration.

Tests made of the effect of size and grading of aggregates have shown that the reason why concrete of higher strength and durability can be produced from well-graded aggregate as compared with a poorly-graded aggregate is that the former can be mixed with less water. If this is not done, no advantage is gained from using a coarse, well-graded aggregate. The following discussion shows that a similar conclusion can now be stated with reference to a rich concrete mixture as compared with a lean one:

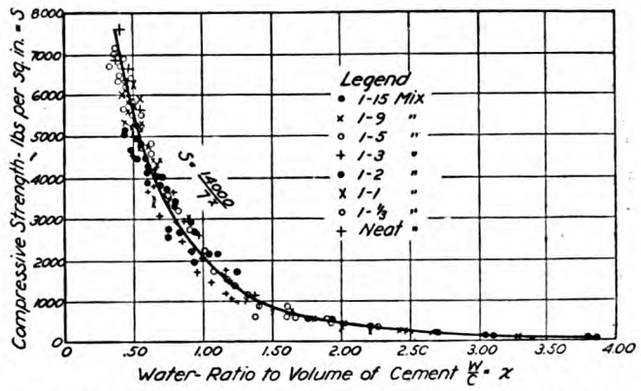
While the injurious effects of too much water in concrete are apparent, tests made in this laboratory show that the fundamental part played by water in concrete mixtures has been overlooked in previous discussions of this subject. The relation mentioned above is emphasized by a series of compression tests of about 1600 six by twelve-inch concrete cylinders made as follows:

Mixture Cement to Aggregate	Range of sizes of aggregates	Consistence
1 to 15		
1 to 9		
1 to 5	0 to 14-mesh sieve	7 different consistences for each mix and aggregate
1 to 3	0 to 4-mesh sieve	
1 to 3	0 to 1¾-in.	
1 to 3	0 to 1½-in.	
1 to 1	0 to 2-in.	
1 to ⅓		
Neat		

The mixtures used covered a wide range, as did also the grading of aggregate and consistence. The aggregates consisted of two sizes of sand and mixtures of sand and pebbles graded to the sizes shown. The mixture is expressed in terms of volumes of dry cement and aggregate, regardless of grading; that is, a 1:5 mix is made of 1 cu. ft. cement (1 sack) and 5 cu. ft. of aggregate as used, whether a sand or a coarse concrete mixture.

This series gives valuable information on the effect of changing the quantity of cement, the size of the aggregate, and the quantity of water. The effect of many different combinations of these variables can be studied. One set of relations gives the effect of amount of cement using aggregates of different size and grading; another set of relations gives the effect of different quantities of water, varying both mixture and size of aggregate, etc. In all respects these tests bear out the indications of both earlier and later series. These tests are of interest in that they reveal for the first time the true relation between the strength and the proportions of the constituent materials in concrete.

The figure shows the relation between the compressive strength and the water content for the 28-day tests. The water content of the concrete has been expressed in terms of the volume of cement, assuming that the cement weighs 94 lb. per cu. ft. Distinguishing marks are used for each mixture, but no distinction is made between aggregates of different size or different consistences.



RELATION BETWEEN COMPRESSIVE STRENGTH AND WATER CONTENT

When the compressive strength is platted against the water in this way, a smooth curve is obtained, because of the overlapping of the points for different mixtures. Values from dry concretes have been omitted. If these were used we should obtain a series of curves dropping downward and to the left from the curve shown. It is seen at once that the size and grading of the aggregate and the quantity of cement are no longer of any importance except in so far as these factors influence the quantity of water required to produce a workable mixture. This gives us a new conception of the function of the constituent materials entering into a concrete mixture and is the most important fact that has been

*Abstract from 'Concrete Highway Magazine.'

†Professor in Charge of Structural Materials Research Laboratory, Lewis Institute, Chicago.

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discoveries in the studies of concrete conducted in our laboratory.

The equation of the curve is of the form,

$$S = \frac{A}{B^x} \ldots\ldots (1)$$

where S is the compressive strength of concrete and x is the ratio of the volume of water to the volume of cement in the batch. A and B are constants whose values depend on the quality of the cement used, the age of the concrete, and the curing-conditions.

This equation expresses the law of strength of concrete so far as the proportions of materials are concerned. For given concrete materials the strength depends on only one factor, the ratio of water to cement. Equations that have been proposed for this purpose contain terms which take into account such factors as quantity of cement, proportions of fine and coarse aggregate, voids in aggregate, etc., but they have uniformly omitted the only item that is of importance; that is, the water.

For the conditions of these tests, equation (1) becomes,

$$S = \frac{14000}{7^x} \ldots\ldots (2)$$

The relation given above holds so long as the concrete is not too dry for maximum strength and the aggregate not too coarse for the given quantity of cement; in other words, so long as we have a workable mixture. Other tests made in this laboratory have shown that the character of the aggregate makes little difference so long as it is clean and not structurally deficient. The absorption of the aggregate must be taken into account if comparison is being made of different aggregates. In certain instances a 1:9 mixture is as strong as a 1:2 mixture, depending only on the water content. The strength of the concrete responds to changes in water, regardless of the reason for these changes.

It should not be concluded that these tests indicate that lean mixtures can be substituted for richer ones without limit. We are always limited by the necessity of using sufficient water to secure a workable mixture. So in the case of the grading of aggregates. The workability of the mixture will in all cases dictate the minimum quantity of water that can be used. The reason a rich mixture gives higher strength than a lean one is that a workable concrete can be produced by a quantity of water which gives a lower ratio of water to cement. If an excess of water is used we are simply wasting cement. Rich mixtures and coarse, well-graded aggregates, are as necessary as ever, but we now know just how these factors affect the strength of the concrete.

Practical use may be made of the curve in estimating the relative strength of concretes in which the water content is different for any reason. For example, a concrete mixed with 7.5 gal. of water (1 cu. ft.) to one sack of cement (allowance being made for absorption of aggregate) gave a strength in this series of 2000 lb. per square inch ($x = 1.00$). For $x = 0.80$ (6 gal. of water per sack of cement) we have 3000 lb. per square inch; for $x = 0.75$ (5.6 gal.) 3300 lb. per square inch. Concrete in a 1:4 mixture (same as the usual 1:2:3 mixture with a coarse sand) should be mixed with $5\frac{1}{2}$ to 6 gal. of water per sack of cement. The importance of any method of mixing, handling, placing, and finishing concrete that will permit the work to be done with a minimum of water is at once apparent.

ACID PROCESS FOR SEWAGE-DISPOSAL

A process for sewage treatment and disposal discovered and patented by George W. Miles, of Boston, is described in a recent number of 'Metallurgical and Chemical Engineering.' Receiving-tanks are constructed at the sewer outfall. At these tanks a small part of the sewage is pumped through an absorption-tower with a counter current of SO_2. The sewage that has been saturated with SO_2 is mixed with the rest of the sewage at a point sufficiently distant from the mouth to ensure thorough mixing. All the sewage then runs into a settling-tank and from there into a second settling-tank. The effluent flows from the second tank. The tanks must be large enough to provide four hours' sedimentation in all. During this period, 98% of the solids recoverable by settling are precipitated. After one set of settling-tanks has been operated for about a week, the sewage is switched to another set of tanks. The sludge, which contains from 80 to 92% of water, is then pumped from the first set of tanks. The sludge is not offensive, and there is no putrefaction. The sludge is pressed and then dried under careful temperature-regulation to prevent burning.

About one ton of SO_2 is required per million gallons of sewage, equivalent to 1000 lb. of sulphur or 2240 lb. of pyrites. Nitre cake and SO_2 can also be used, in the proportion of 3.82 tons of nitre cake and 200 lb. SO_2 per million gallons of sewage. The amount of sludge varies, of course, with the character of the sewage. With average city sewage there will be about 2000 lb. of sludge per million gallons, containing 400 lb. of grease. The grease is extracted from the sludge and the remainder can be used for fertilizer. The grease-free sludge contains about 4.5% of NH_3 and between 1 and 2% of P_2O_5.

The cost of the process and the value of the products have both been affected by war-conditions. With prewar prices, the cost of the acid treatment would not exceed \$9 per million gallons of sewage. The value of the grease recovered would be \$16 and of the sludge as fertilizer, \$10.20 per million gallons, making \$26.20 in all, and leaving \$17.20 to cover the cost of drying and extracting the grease from the sludge. With prices as of January 1918, the cost of treatment would be \$20, and the value of the grease and fertilizer, \$90.94 per million gallons, leaving \$70.94 for drying and extracting grease.

Manila rope may be preserved from decay by coating it with a mixture composed of equal parts of beeswax and resin melted together, and applied with a paintbrush.—'Practical Engineer.'

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Effect of Re-Absorption of Moisture on the Compressive Strength of Air-Dried Timber*

By IRVING H. COWDREY†

An investigation has recently been completed on the effect of re-absorption of moisture on air-dried douglas fir and Southern hard pine. The stock used was purchased in the open market without any special care in selection. In the form of 4-in. planks it remained in the testing laboratories about six months under the conditions of heat and moisture ordinarily pertaining to such localities, being open to free and complete circulation of air over and around the material.

Tests showed the moisture content to be between 6 and 8% for all pieces. The timber, then, may be considered to have been thoroughly air-dried. From these planks were cut specimens, which were planed to a section 2 by 2 by 20 in. These pieces were cut further into blocks 8 in. long, and the pairs thus obtained were used in most cases under similar conditions of treatment for check purposes. Treatments were conducted on specimens 8 in. long. Tests were made on specimens 6 in. long formed by the removal of 1 in from each end of the treated specimen.

A number of specimens of both pine and fir were tested in the air-dry condition to establish their initial properties. One set consisting of 20 pieces of pine and 20 pieces of fir was subjected for various periods of time to a saturated atmosphere at 120°F. Another similar set was immersed in fresh water at 70°F. for various periods of time.

While the moisture even in so thin a block as those investigated will vary from surface to surface, yet it is sufficiently accurate for the purposes of this paper to take the average value as representative of the conditions at the centre of the section. These values are plotted in the curves of Fig. 1 and 2. The water present in wood may exist (*a*) as free water within the cellular spaces, the canals and ducts, and possibly to some slight extent in the intercellular cavities; and (*b*) as water which has been actually absorbed by the material which constitutes the cell-walls.

It is commonly supposed that the absorption of water from moist air at least is first an absorption by the cell-walls, and that later under some conditions there occurs a partial filling of the cell-cavities. The maximum water content possible without the presence of free water in the cells and canals is known as the 'fibre-saturation point.' When water is absorbed because of the actual immersion of the wood it is likely that free water may exist in the cells without the cell-walls having absorbed a quantity sufficient to produce fibre-saturation. For most of the commoner timbers this fibre-saturation point occurs at a moisture content of approximately 25%. Most writers consider that it is only this second form, or 'imbibed' water, as it is sometimes called, that affects the strength. No satisfactory theories have been advanced to elucidate the phenomenon. It seems to me that perhaps some of the effects of colloidal solution may occur, which may to some extent be confirmed by the fact that complete kiln-drying at high temperature prevents or markedly decreases certain effects commonly produced by re-absorption of moisture, such as swelling and increase of pliability. Again, I believe that the free water in the cells and canals may also have a weakening effect, due to re-solution of some of the salts which are undoubtedly deposited within the cells as the sap dries out, or in the case of heart-wood by infiltration during the life of the tree. These crystalline deposits must have a stiffening effect, and, if present in sufficient quantity to fill the cell completely or to bridge it at any point, should add materially to the rigidity of the cell, as latticing adds to the rigidity of structural compression-members.

Only the rate of penetration in the direction of the fibre was investigated. The specimens, in the form of blocks 2 by 2 by 8 in. were subjected to the desired treatment for periods ranging from 1 to 117 hours. At the end of the period of treatment the moisture content was determined.

Re-absorption When Exposed to Saturated Air at 120°F. The specimens were treated by placing them on a grid just above the surface of hot water in a covered steamer freely vented to the air. The temperature of the vapor in the steamer was maintained within the limits of 2°F. variation during the longest period of treatment, namely, 24 hours.

Fig. 1 shows the re-absorption of the specimens during periods of 1, 3, 9, and 24 hours of treatment. Referring to curves *P*-1 and *F*-1 representing the conditions at the end of an hour's treatment, it will be noticed that no re-absorption was manifest beyond a point approximately 1½ in. from the end. The curves *F*-3 and *P*-3, showing the effect of 3 hours treatment, indicate some absorption, even at a distance of 4-in. from the exposed end-grain. In none of the treatments did the re-absorption become greater than 12% average moisture in the first ¼ in. from the end. With the air-dry condition of 8% of moisture or less, giving total moisture 20% or less, it would seem that the fibre-saturation point was not attained. However, the point

*Abstract from 'Journal' of American Society of Mechanical Engineers.

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plotted represents the average for the first ¼ in., and the moisture content decreases rapidly at first; hence it seems fair to presume that the walls of the cells immediately adjacent to the surface may have reached the point of saturation. From this it might be inferred that saturated air at 120° F. is capable of producing fibre-saturation. It seems also reasonable to suppose that if the treatment were continued for a period of sufficient length this condition might extend throughout the timber regardless of size. The logical conclusion is that timbers subjected to the action of saturated air at 120° F. must be designed on a basis of constants determined from tests on green timber.

Re-absorption When Completely Immersed in Fresh Water at 70° F. Re-absorption tests were made at the end of 1, 24, 48, 72, and 117 hours. The observations were all concordant, and hence only the data obtained from the 24, 48, and 117-hour periods have been plotted

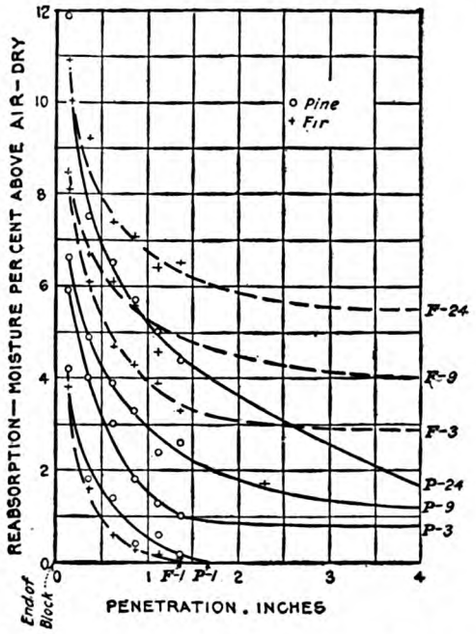

FIG. 1. RE-ABSORPTION OF SPECIMENS IN SATURATED AIR AT 120°F. P-1 INDICATES PINE TREATED 1 HOUR, F-24, FIR TREATED 24 HOURS.

in Fig. 2. Here the relative re-absorptive powers of pine and fir are much more nearly alike than in the case of the treatment in saturated air. Yet even here it will be noted that in all cases the re-absorptive power of the fir is slightly greater than that of the pine. While the time required for fibre saturation is not definite in the case of timber immersed in water, yet an inspection of the curves of Fig. 2 shows clearly that such saturation undoubtedly occurs, and that it is only a matter of time when columns or beams of timber, even though previously air-dried, will be reduced to the character of green wood.

Comparison of Fig. 1 and 2 beyond the first half-inch from the exposed end shows that the rapidity of re-absorption is much less when the wood is immersed in water at 70° F. than when exposed to air saturated at 120° F. In detail it will be noted that 24 hours in water are required to produce approximately the same re-absorption as 3 hours' treatment in moist air, and that the re-absorption after 48 hours' submersion is approximately that attained during a 24-hour exposure to moist air.

Fig. 3 and 4 have been prepared to show the relations between the moisture content and the crushing-strength of the two woods under discussion. All of the fir tested, with two exceptions, showed from 12 to 17 rings per inch measured radially; the summer wood comprised from 30 to 60% of the total growth; the air-dry density ranged between 31 and 36 lb. per cubic foot. The pine under investigation showed from 7 to 10 rings per inch measured radially. The summer wood ranged from 30 to 50% of the total strength. The

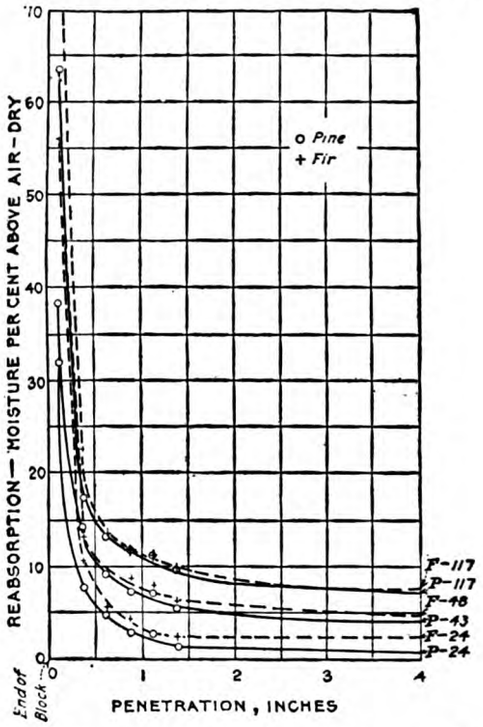

FIG. 2. RE-ABSORPTION OF SPECIMENS IN FRESH WATER AT 70°F. P-24 INDICATES PINE TREATED 24 HOURS, F-117, FIR TREATED 117 HOURS.

air-dry density was between 32 and 36 lb. per cubic foot. Pine specimens *S* had but 6 rings per inch, showing only 25% summer wood, and an air-dry density of about 30 lb. per cubic foot. It is evident that the wood from which these were cut should be classed as 'sound' rather than as 'dense' southern pine according to the American Society for Testing Materials standards.

Fig. 3 shows that the compressive strength of the wood decreases as the moisture content increases. The data were obtained as previously explained from tests made on specimens subjected to radically different treatments. In the case of the fir, nevertheless, the resulting curve is evidently a continuous line. The inclination is somewhat steeper with the lower moisture contents and becomes approximately horizontal at a moisture content of about 25%. This corresponds

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closely with the fibre-saturation point previously mentioned and confirms the existing theory that only the 'imbibed' moisture affects the strength in compression. It will be noted that the treatment of wood by exposure to air saturated at a temperature of 120° F. results in a compressive strength about 25% less than the strength of air-dry timber. This reduction appears at about 14% moisture content. Submersion in water at 70° F. for a period of 117 hours produces at the point of fracture a moisture content of 26%, thereby reducing the strength to a value about 40% below that of air-dry wood of the same quality.

The data recorded in Fig. 4 offer marked variations from those shown for fir in Fig. 3, the curve for which has been transposed to this figure as a dash line. The data obtained from the pine give plotted points that cannot be satisfactorily represented by a single line. The data from the water-soaked specimen, marked *W*, yield a fairly determinate curve. The data from the

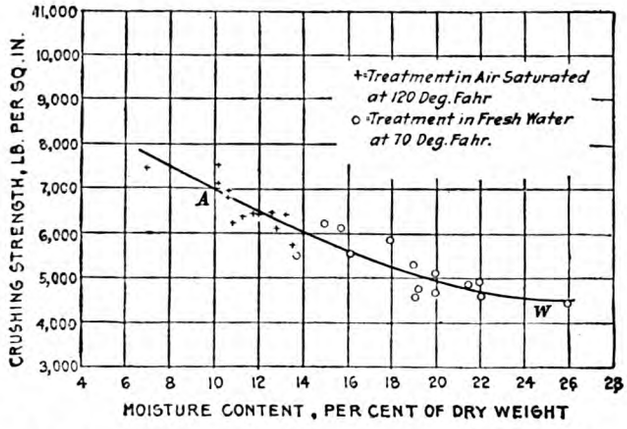

FIG. 3. RELATION BETWEEN MOISTURE CONTENT AND CRUSHING-STRENGTH OF DOUGLAS FIR.

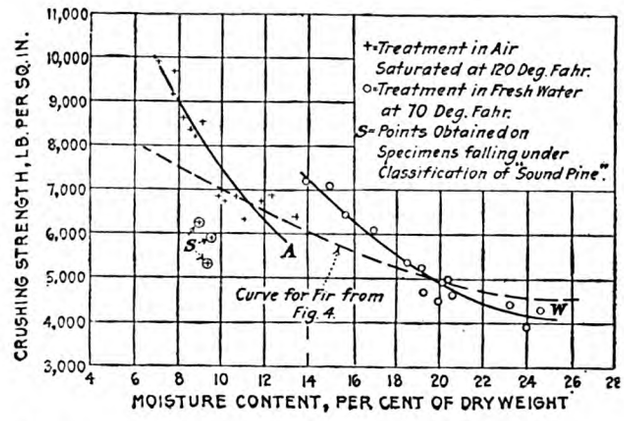

FIG. 4. RELATION BETWEEN MOISTURE CONTENT AND CRUSHING-STRENGTH OF PINE.

specimens exposed to the moist air, marked *A*, might be represented by a variety of lines. However, it seems fair to presume that the two lines will be of the same general type, even though they are discontinuous. Such has been the assumption used as a guide in drawing the representative lines.

The generalizations for the pine are similar to those for the fir. The decrease in strength with the increase of moisture content is rapid at first. It later flattens, becoming nearly horizontal at about 25% moisture content, again indicating this value as the fibre-saturation point. The rate of decrease in strength seems to be more rapid for pine than for fir. This decrease is about 35% after 24 hours' exposure to air saturated at 120° F. It is only fair to suggest that this decrease may not be caused entirely by moisture, which point is discussed in a later paragraph.

Because of the extremely rapid re-absorption, no points were obtained for the soaked specimens between the air-dry condition and about 14% of moisture. The curve *W* as drawn, however, if extrapolated as a straight line will pass close to the points obtained for the air-dry material. This curve shows that the moisture content of about 25% which was present 1 in. from the exposed end after a soaking of 117 hours, resulted in a strength nearly 60% below the strength of the air-dry material.

The wood treated to the moist air at 120° F. was tested immediately upon removal from the steamer. It was warm when subjected to pressure; in some cases the temperature of the inner portions was probably at least 100° F. Pine is a resinous wood. At the temperatures maintained this resinous material will soften, and some of the normally solid constituents will become liquefied. The parts normally in the state of a liquid of high viscosity will have their viscosity lowered considerably. The effect of this action will be a general removal of the stiffening action of the cell-contents and possibly a lubricating effect tending to permit greater freedom of movement between cells that are poorly adherent because of incidents of growth. This effect is additive to the general effect of the absorption of moisture and may explain the sharp pitch of the curve *A*.

The temperature of the water (70° F.) used for the soaking treatment is probably insufficient to produce the above-noted effect. In fact, the temperature is approximately that at which the air-dry specimens were tested. The temperature factor may reasonably be eliminated from a discussion of the curve *W*. If such be the case, it is to be expected that a given moisture content when obtained in the water at 70° F. will show a less marked weakening effect than does the same moisture content when caused by exposure to moist air at 120° F. Observing the conditions at a moisture content of 14%, such is found to be the case. The difference between the ordinates of curves *A* and *W* at this degree of saturation may be taken to represent the weakening effect of heat caused by softening of the resinous compounds by heating for 24 hours at 120° F. Since the quantity of resinous matter in the fir is much less than that in the pine, this temperature effect would be absent. The specimens giving the points marked *S* show that wood of coarse growth, low proportion of summer wood, and corresponding lesser density yields

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a lower compressive strength than when the reverse conditions obtain.

In the interpretation and use of the data furnished in this paper, it must be kept in mind that the specimens tested were brought in the open market; that no special selection of material was made except so far as was necessary to obtain specimens of reasonably straight grain, free from knots and serious defects; that tests were made on small specimens, limited in number and selected from a small initial quantity of lumber; that in consequence of the above facts the results must be considered comparative and qualitative rather than definitely quantitative. With the above in mind the following conclusions are given:

In the air-dry condition with approximately equal moisture content the compressive strength of hard pine is about 25% greater than that of douglas fir.

When exposed to air saturated with water vapor at 120° F. and when immersed in fresh water at 70° F., the moisture re-absorption of air-dried wood is greater and more rapid in the case of fir than in the case of pine.

The temperature effect on strength decrease is of more importance on pine than on fir.

Pine shows a more rapid decrease in strength with the moisture increase than does fir. The more rapid re-absorption by fir tends to offset this effect when the time element is used as a basis, so that for a given time of treatment the pine remains the stronger, although the strengths tend to approach each other with more extended treatment.

For moisture content above 11% when due to re-absorption from air saturated at 120° F., the fir is stronger in compression than is the pine. The same relation appears for moisture contents greater than 20% when due to soaking in fresh water at 70° Fahrenheit.

STATISTICS OF AMERICAN RAILWAYS

The Bureau of Railway Economics has recently issued Bulletin No. 120 'Statistics of Railways, 1906-1916, United States', containing about 50 closely-printed pages of tabulated statistics of all aspects of the railway situation.

In 1916 there were, exclusive of locomotives used by switching and terminal companies, 63,862 locomotives, with an average tractive power of 32,423 lb. The average tractive power in 1906 was 24,741 lb., showing an increase of over 30%. The number of freight-cars in 1906 was 1,837,914 with an average capacity of 32 tons. In 1916 this number had increased to 2,326,987 and the average capacity to 40 tons. In the last-named year, 550,496 freight-cars were made entirely of steel and 734,499 more had steel under-frames. Out of 54,664 cars in passenger-service, 10,884 were entirely of steel and 5197 had steel under-frames.

The total freight-traffic in 1916 amounted to 1,238,222,097 tons, of which 115,781,914 tons, or 9.35% was products of agriculture, 29,944,598 tons, or 2.42% was products of animals, 706,029,210 tons, or 57.02% was products of mines, 106,856,873 tons, or 8.63% was products of forects, 186,833,830 tons, or 15.09% was manufactures, 51,652,836 tons, or 4.17% was merchandise, and 41,123,646 tons, or 3.32% was classed as miscellaneous.

During the ten years from 1906 to 1916 the average number of freight-cars per train increased from 26.5 to 34.9, and the average number of loaded cars per train from 18.2 to 23.4. The average haul for freight increased from 240.98 to 276.88 miles. The average car-load per loaded car increased from 18.9 to 22.4 tons. In other words 56% of the car capacity was used. Passenger-miles per inhabitant increased from 294.1 to 335.4.

The statistics for accidents cover the years from 1911 to 1916. For the fiscal year ended June 30, 1916, there were 141 passengers killed and 3850 injured in train-accidents. The total number killed in train-accidents was 549 and the total number injured was 7697. While this is somewhat higher than for the preceding year, it is only a little more than half the number in either 1911, 1912, or 1913, indicating considerable progress in the direction of 'safety first', since the amount of traffic increased considerably during that time. Casualties caused by other than train-accidents do not show any such gratifying decrease. The number killed during the year ended June 30, 1916, was as follows: passengers, 142; employees on duty, 1668; employees, not on duty, 292; other persons, non-trespassers, 1464; trespassers, 4763; total, 8329. The number injured was passengers, 4529; employees on duty, 39,074; employees not on duty, 666; other persons, non-trespassers, 4347; trespassers, 4990; total, 53,606. While there is some variation from year to year, there is no sign of any continued tendency toward either increase or decrease in any of these figures. Of course, on account of the increase of both traffic and population, no numerical increase indicates an actual decrease. As usual, the good old American custom of walking on the railroad track is responsible for more than half the fatal accidents and a large proportion of the injuries.

The statistics of grade-crossings show that there are 259,496 in the United States, of which 244,449 are with streets and highways and the remainder with electric street or interurban railroads or with other steam-railroads. There is some duplication in the number of crossings with other railroads on account of the same crossing being returned by two railroads. The number of crossings protected by gates, flagmen, interlocking devices, or crossing-alarms is 34,796, while 224,700 crossings are unprotected except by signs. During the year 689 grade-crossings were eliminated. At this rate it will take 377 years to eliminate the entire number, assuming that no more grade-crossings are constructed during that time.

The temperatures attained in the cylinders of gas-engines may vary considerably, but in some instances, at the top of the explosion-stroke, the temperature is 2700° F., with a minimum, during suction-stroke, of 250°, and an average of 950° during the complete cycle. These are the temperatures of the gases in the cylinder, not of the cylinder-walls.—'The Gas Engine.'

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Military Highways*

By LOGAN WALLER PAGE†

In its broadest sense a military highway can be defined as any highway over which equipment, men, or supplies are transported in the conduct of military operations. It may be placed to serve a base of supplies, to connect the base with the front line of action, or to distribute supplies behind the firing-lines. In the conduct of modern warfare the highway plays an important part, because, in addition to its use as an avenue for marching troops, supply-wagon trains, cavalry, and artillery, it affords a means of rapid transport that is easily, quickly, and economically constructed for carrying heavy units of artillery and accessories, and for moving large numbers of troops quickly from one part of the field of action to another by motor vehicles, as has been so often required in the present war. The value of possessing a comprehensive system of military highways becomes at once apparent when we hear that France was practically saved by its system of roads and the great number of available motor busses, which conveyed troops quickly to the point of attack. We must, however, remember that the present system at the French fighting-front was not complete at the start, but consists in considerable part of extensions to main arteries that were built years ago according to a program having the civil as well as the military needs as a basis of design.

This, in fact, is the only basis upon which any comprehensive system of highways can be designed. Any system not based upon the civil as well as the military problems involved is not only uneconomical but unstrategic. The present war has demonstrated that the organization of all civil as well as all military elements is essential to the rapid production of supplies and their speedy delivery.

The French road system as it existed has not provided local fighting-line roads except as the forces have taken up positions along the highways. In the planning of the military roads in France there is apparent no idea of providing roads to accommodate traffic necessary on a hypothetical battlefield. Manoeuvring for strategic advantage in position has considered the existing roads as topographical features. The battlefields have in part been controlled by the roads, rather than the reverse. In the system as built, important centres were systematically connected. Through truck roads were provided, and the radial system actually existing developed as a result of these primary considerations. Main roads from Paris to all large centres in France furnish Paris with a radial system, and similarly for the lesser cities of France. The development of the local network existed to some degree in the French system in August, 1914, but many miles of local roads have been built behind the fighting lines, not only to replace destroyed roads but to serve local military purposes. Reports from Italy state that 4000 miles of such roads have been built. Our problem, then, is not to develop a local network over small areas, but to provide a series of main arteries between the large centres. Furthermore, if we should undertake to develop highways for military or any other purposes on the same scale that France has done, there would be 32,000 miles of national roads in the State of Texas, and four times that mileage of inter-county roads; there would be as many main roads in New York and Pennsylvania as there are in Germany, and as many in New England as in England, Scotland, and Wales. The development of such a system in detail would be unwarranted by our present economic requirements in times of peace.

The local construction of so close a network of roads would not be warranted over any one area to the exclusion of others. The total battle-line on the Western Front, although extending from Switzerland to the Channel, is not so long as the distance from Washington to Boston. The over-development of roads in such an area at the expense of a less development over a much larger area would obviously be a serious error. An enemy would simply attack in some region where the system did not exist. To adapt the radial system of Germany or the old Roman system of Italy and France to the United States without modification or adjustment to American conditions and distances would be not only uneconomical but would also be a military failure.

It appears plain, then, that the underlying principle of road planning is to provide the net of through roads over the entire area of boundary, choosing first those areas most open to attack. Certain areas are obviously within this class; such as (*a*) the area about Long Island, comprising the New England States and New York; (*b*) the area about Chesapeake bay, comprising much of New Jersey, Pennsylvania, Maryland, Delaware, Virginia, and North Carolina; (*c*) the Pacific Coast area; (*d*) the Mexican border, comprising the southern part of Texas, New Mexico, and Arizona; (*e*) the Great Lakes area, comprising parts of the Lake States; and (*f*) the Gulf area, comprising parts of the Gulf and southern Atlantic States.

In addition to a network of roads connecting the centres of poulation in these areas there should be through roads leading inland to important centres of manufacture and supply. The number of these neces-

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sarily depends on economic conditions. Roads should connect the Pittsburgh, Cincinnati, Detroit, Chicago, Birmingham, and other big industrial districts with the coasts. Such roads have already been found to provide a much needed type of communication, although they would appear on casual thought to be of little value, inasmuch as they parallel main rail-lines with a lower and less useful form of roadbed.

As the probable demands arising from war conditions on any particular part of the highway net cannot be foreseen, for the simple reason that the actions of an enemy cannot be foretold, we find that the immediate economic and engineering considerations under peace conditions are those that must control in planning these roads. The density of traffic under peace conditions never can equal that caused by the demands of war, and any attempt to meet the possible military demands on all roads would result in a breakdown of the highway policy when considered from no other than an economical standpoint. For example, the Bar le Duc-Verdun road in France, about 50 miles long, was forced to carry, during the months of the attack on Verdun, a continuous line of 5000 motor trucks throughout the day and night. Traffic moved in four lines along the highway, the speed of the vehicles varying with the line in which they traveled. Slow-moving horse-drawn vehicles moved along the shoulders. Trucks moved at a rate of about 12 miles per hour, spaced 50 ft. apart.

The military road should therefore be the most economical one, just as the ordinary highway. Except in cases of emergency, the usual considerations are applicable. The most economical highway under all conditions is the one that has the longest life for the amount of money invested and that serves its traffic with ease and safety. In general, a military road should be designed to carry traffic without delay or confusion, and with a minimum of effort.

The design of military highways is controlled by the same details as for ordinary highway construction. A slight adjustment of some of our assumptions of design should be made. Grades should not exceed 5%, except that an emergency maximum of 10% for not more than 150 ft. may be allowed. Alignment should have no curves with radius less than 200 ft., and a clear view of not less than 300 ft. The road foundations and bridge structures should be designed and built to carry at least 6000 lb. forward and 8000 lb. rearward on a wheel-base 5 by 10 ft. The paved surface should be 20 ft. and the grade 30 ft. wide.

Much has been said lately of materials and methods of construction. It appears, from the most reliable sources of information, that water-bound macadam, telford, V-drains, and stone base are the most effective types of construction for military roads. We know that such a type is not economical in many localities in time of peace. For this reason the type selected for use in our suggested system may be in accordance with current economic rather than possible military demands. But it must be remembered that the requirements of maintenance controls under actual fighting conditions. Repairs must be made easily, rapidly, and without interrupting or diverting traffic. The traffic carried by the Bar le Duc-Verdun road was astounding in its wear and could not be halted. Just what our American types of so-called permanent pavement would have suffered is hard to determine, as none of them are found to any great extent in the European zones of activity. Many of them would doubtless stand heavy pounding for a longer time than the macadam, but when rupture came the requirement of immediate repair would force resort to materials and methods capable of rapid and effective application.

The records furnished us so far indicate that either water-bound or clay-bound macadam have been generally used by the French and English immediately behind the Western Front. In the accounts, however, little distinction has been made between the roads actually within the range of shell-fire, in what might be called the battle area, and those to the rear. It seems most likely that American practice can develop an improvement over the water-bound macadam patching in both areas, especially on the main roads beyond range of shells. The advance that we have made in the last five years in the development of cold-patch materials and their use indicates the great possibilities in this direction. This method can be used on almost any type of wearing surface, from ordinary water-bound macadam to concrete or brick. So if we have any given system of roads constructed to meet the demands of normal traffic in times of peace, these roads may be repaired either with cold patches or water-bound patches. Roads built or re-built as the immediate accessories of an advance must be of materials that consolidate and furnish a traveled way in the least time. Such roads will probably be either water-bound macadam or gravel. Likewise the repair of these roads, so long as they remain a part of the battle area, will have to continue in part of this type, or perhaps, under some conditions, be of cold-patch materials.

The question of shell-holes is interesting, but the destruction from this cause is less than the layman supposes. Shells that would bury themselves in loose earth before exploding burst almost at contact with a hard road-surface and expend much of their force in the direction of least resistance. Consequently, shell-holes on the roads are much shallower and smaller than in the fields. Moreover, it is costly business wasting ammunition in indiscriminate shelling of roads. Such destruction as occurs is usually the result of attempts to destroy motor trains or other transports passing over the roads, and is concentrated over a small area. Attempts to cut a road by shell-fire are usually directed at points where aeroplane photographs indicate cuts or fills. The shelling aims to blow in the cut or blow out the fill. As a matter of fact, there appears to be little shelling of roads merely as such.

For these reasons most repair work is the replacing of worn or scattered road metal. There appears to be nothing unusual in the methods used to make these replacements. A roller cannot be used ordinarily until

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traffic is reduced so that only one-half of the road surface is required. Then the rollers are used and the surface thoroughly repaired. Roads that have been gradually eliminated from the battle zone by advancing forces are at the earliest moment practically re-built. If the same series of events occurred in the United States it appears probable that, with the persistence of heavy traffic even after the road has passed beyond shell-fire, its reconstruction would have to be rapid and conducted so as to cause a minimum interference with traffic. For this reason it appears most probable that, regardless of the original type, such reconstruction would generally be of gravel or macadam, at least until the fighting passed entirely from the region tributary to the road.

We have no data that will lead to a choice of materials with respect to an effort to produce the effect of camouflage. The French engineers have generally given up attempts to disguise a highway. The reason for this is obvious. The enemy determines the position of these roads in the first instance from maps secured in time of peace. He corroborates his evidence by photographs taken from observation balloons or aeroplanes. The reflection of light from the regular road-surface shows in the picture regardless of the color of the surface. The road always appears in the photograph in contrast with the surrounding terrain, from which the reflection is irregular. The local attempts at camouflage are now confined to the distribution of branches or brush so as to cast irregular shadows across the surface. In this connection a detail of importance is the suppression of dust. Although the roads are not gratuitously and promiscuously shelled, they are watched, and if a cloud of rising dust indicates the passage of a support train or ambulance, that cloud at once becomes a target. The use of light oils or other familiar dust palliatives is of advantage. This also reduces the chance of accident from driving into a fog of dust.

In the light of military requirements, the need of centralized road control is emphasized just as it is by the ordinary economic requirements of the nation at large. It is the one really serious difficulty in our present road situation. There are small groups of roads in specially created road districts, built with the proceeds of bond issues for which the district is liable. These roads are frequently under the sole charge of bond trustees. In the same county or township there may be other roads under the jurisdiction and control of the county commissioners. Still other roads in the same county may be jointly under the State and county, the latter being directly responsible for maintenance and the former having none but a supervisory authority so long as the county does this maintenance properly. Then there may be a State road across the county over which the State has full control to build and maintain. Finally, there may be a Federal Aid road, and this road may be a part of a road in any of the classes mentioned above. Over the Federal Aid road once constructed the Government has no control except that if the road be not properly maintained the Government may refuse further aid, at the end of four months, to the particular local unit responsible for the maintenance.

Under such a dispersion of authority it has been in the past, and doubtless will continue in the future to be, almost impossible to secure the systematic continuous construction and maintenance of important roads where the jurisdiction and the control of funds are lodged in so many different bodies. It is apparent, from the information that comes to us from Europe, that some centralized control of the roads over a considerable area becomes imperative with the occurrence of special military needs. Roads will have to be built and maintained regardless of the local political boundaries, and it appears that any administrative unit smaller than the State would fail to serve adequately the demands that will arise. Such condition, however, is no more pertinent to the possible military uses of highways than to the present economic demand, and the same degree of centralized control is essential in peace as would be required in time of war. The gradual extension and development of this control is therefore warranted in peace as much as it would ever be, for only through such control can the completion of the most necessary roads be accomplished, an advantageous uniformity of construction be attained, and adequate maintenance at all times be assured.

COST OF CENTRAL-STATION STEAM

An examination of the schedules of rates in 28 cities of from 25,000 to 400,000 inhabitants, covering many of the Middle States and ranging in latitude from Michigan and New York to Georgia and Alabama, shows the highest minimum to be $1.50 per 1000 lb. of steam at Peoria, Illinois, and the lowest for maximum consumption to be $0.3105 at St. Joseph, Missouri. The lowest minimum consumption rate is $0.54 at Penn Yan and Geneva, New York. The rate at these points for maximum consumption is $0.4635. The average minimum and maximum rates for the 28 cities, on quantities of 4000 lb. or less, and 300,000 lb. or more per month, are $0.764 and $0.4533, respectively. While a study of the rates referred to shows an entire lack of uniformity in the methods of their deduction, the averages given confirm, in general, the costs which have been established herein for furnishing 1000 lb. of steam. In about half of the schedules mentioned, there is a minimum demand charge of $3 per month on all building having a capacity of 25,000 cu. ft. of space or less, and of $0.12 per 1000 cu. ft. on all buildings having more than 25,000 cubic feet.—John C. White in the 'National Engineer.'

Plowing with tractors on the Sun River, Montana, project of the U. S. Reclamation Service, cost $5.75 per acre, of which $1.13 was for fuel and $0.21 was for lubricants. The tractors were operated by the Government. Two 8-hour shifts were run.

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Recommended Practice for Concrete-Bridge Construction

The following general specifications have been prepared by the engineers of the Portland Cement Association. They are based on the recommendations of the Committee on Bridges of the American Concrete Institute and on parts of Bulletin No. 10 of the Illinois State Highway Department, 'A Manual for County Superintendents of Highways, Resident Engineers, and Inspectors.'

Materials

Cement. The cement should meet the requirements of the current standard specifications for portland cement of the American Society for Testing Materials. Adequate provision should be made for storage of cement on the work and for protection against dampness in storage.

Aggregates. Before aggregates are delivered on the job, contractors should submit to the engineer a 50-lb. sample of each of the aggregates proposed for use. These samples should be selected so as to represent fairly the average quality and grading of the aggregates in question. The samples submitted should be tested and, if found to pass the requirements of the specifications, similar material should be considered as acceptable for the work. Aggregate containing frost or lumps of frozen materials must not be used. Fine and coarse aggregate should not be piled so near each other that the edges of the piles overlap. Aggregate should preferably be stored on a platform so that the material in the bottom of the pile will not become mixed with dirt during wet weather, thus lowering the strength of the concrete.

Fine Aggregate. Fine aggregate should consist of natural sand or screenings from hard, tough, crushed rock or pebbles, graded from fine to coarse, with the coarse particles predominating. Fine aggregate when dry should pass a screen having 4 meshes per linear inch. Not more than 25% should pass a sieve having 50 meshes per linear inch, and not more than 6% should pass a sieve having 100 meshes per linear inch. Fine aggregate should not contain injurious vegetal or other organic matter, as indicated by the colorimetric test,* nor more than 7% by volume of clay or silt as determined by washing the sand thoroughly in 100% excess of water and allowing the silt to settle for one hour. Field tests should be made by the engineer on the fine aggregate as delivered at different times during the progress of the work. If the above requirements regarding organic matter and silt are not fulfilled, the material represented by the samples should be rejected.

*The colorimetric test is described fully in Bulletin No. 1, entitled 'Colorimetric Test for Organic Impurities in Sands,' issued by the Structural Materials Research Laboratory, Lewis Institute, Chicago. This bulletin may be obtained from the Portland Cement Association.

Fine aggregate should be of such quality that mortar composed of one part of portland cement and three parts fine aggregate, by weight, when made into briquettes or cylinders, shows a tensile or compressive strength at 7 and 28 days at least equal to the strength of briquettes or cylinders composed of one part of the same cement and three parts of standard Ottawa sand by weight. The proportion of water used in making the test pieces of cement and fine aggregate should be such as to produce a mortar of the same consistence as that of the Ottawa sand test-pieces of normal consistence. In other respects briquettes or cylinders should be made in accordance with the methods of testing cement recommended by the American Society for Testing Materials.

Coarse Aggregate. Coarse aggregate should consist of clean, durable, crushed rock or pebbles graded in size, free from vegetal or other organic matter and should be practically free from soft, flat, or elongated particles. The coarse aggregate should be well graded from 1½ in. down (1 in. for reinforced concrete), not more than 5% passing a screen having four meshes per linear inch.

Rubble Stone. For mass work 'one-man' stones may be embedded in the concrete provided that they are not placed nearer than 6 in. to the outer surface of the concrete and not closer to each other than 6 in. The quantity of such stone should not exceed 30% of the cubical content of the wall or foundation.

Mixed Aggregate. Crusher-run stone, bank-run gravel or mixtures of fine and coarse aggregate prepared before delivery on the work should not be used, because the ratio of fine to coarse material varies so widely as to lead to mixtures of greatly varying proportions.

Water. Water should be clean and free from oil, acid, alkali, or vegetal matter.

Reinforcement. Reinforcing metal should meet the requirements of the current standard specifications for steel reinforcement of the American Society for Testing Materials. It should be free from excessive rust, scale, paint, or coatings of any character that would tend to reduce or destroy the bond. Either plain or deformed steel bars should be used unless otherwise specified by the engineer. When deformed bars are used they should have a net cross-sectional area equivalent to that of the plain bars shown on the plans. All reinforcing metal should be so stored and handled at the work as to ensure its being placed in the structure in a clean condition.

Joint-Filler. The expansion-joint filler should be either a suitable elastic waterproof compound, which will not become soft and run in hot weather, nor become hard and chip in cold weather; or else prepared

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strips of fibre matrix and bitumen as approved by the engineer.

Construction

Forms. Forms should be substantial, unyielding, and so constructed that the concrete conforms to the designed dimensions and should also be tight to prevent leakage of mortar. The forms for exposed surfaces should be sound lumber, planed to a uniform thickness, either tongued and grooved, or with edges beveled to make tight joints after erection. Special attention should be given shores for beams, girder, and slab work, wall-ties, bracing for walls, and centring for arch-form supports, in order to ensure the completion of the work without sagging and deformation. The supports for bridge floors, beams, girders, and arches should remain in place until time for removal, as hereinafter recommended. Forms should be filleted at all sharp corners. For all projections such as girders and copings, the forms should be given a bevel or draw sufficient to ensure easy removal. Forms should be painted with boiled linseed oil or other equally good preparation to prevent the concrete from adhering to the same. A coat of ordinary whitewash is effective. Crude oil or any material that will stick to or discolor the concrete, such as tar paper, should not be used. Care should be taken to secure perfect alignment of rail and girder forms. Local kinks should be eliminated before the concrete is placed.

Placing Reinforcement. Reinforcement should be placed in the position shown on the plans and should be wired at intersections so that it will not become disarranged during the depositing of the concrete. Where bars are spliced, a length of lap sufficient to develop the full strength of bar should be used. If clips of an approved design or other method of connecting rigidly the bars of a reinforcing member be used, the length of lap may be decreased an amount depending upon the nature of the connections. Splices at points of maximum stress should be avoided. Steel should not be laid directly on forms and raised during placing of concrete by prying it up and working concrete under it. The steel should be laid on small stones or blocks of concrete, which may remain when the concrete is placed. In general, steel should be placed securely before concrete is deposited.

Measuring and Mixing

Measuring. The method of measuring the materials for the concrete or mortar, including water, should be one that will ensure separate and uniform proportions of each of the materials at all times. Uniformity of proportions for the aggregates can best be maintained by the use of bottomless measuring boxes or wheelbarrows whose capacities have been determined. A sack of portland cement (94 lb. net) should be considered as one cubic foot.

Machine Mixing. Concrete should be mixed by machine except when the engineer permits otherwise under special conditions. A batch-mixer of an approved type should be used. The ingredients of the concrete or mortar should be mixed to the specified consistence. The mixing should continue at least one minute after all materials are in the drum before any part of the batch is discharged from the drum. The drum should be emptied completely before receiving materials for the succeeding batch. The volume of the mixed material used per batch should not exceed the manufacturer's rated capacity of the drum in cubic feet of mixed material. The mixer should be equipped with water storage and a measuring device which can be locked, also with a suitable charging-hopper.

Hand Mixing. When it is necessary to mix by hand, the materials should be mixed dry on a water-tight platform until the mixture is of uniform color, the required amount of water added, and the mixing continued until the mass is of uniform consistence and is homogeneous. The concrete should be placed in the work within 30 minutes after the water is added to the dry materials.

Re-tempering. Re-tempering of mortar or concrete that has hardened partly, that is, re-mixing with or without additional materials or water, should not be permitted.

Gravity Abutments, Wing-Walls, and Piers

Proportions. Concrete for abutments and wing-walls should be mixed in the proportions of one sack of portland cement to not more than two and a half cubic feet of fine aggregate and five cubic feet of coarse aggregate.

Consistence. Sufficient water should be added to the dry materials to produce a concrete of a consistence such that it will flow slowly into the forms, but can be handled to place without a separation of the coarse aggregate from the mortar. This consistence is best described as 'quaky.'

Placing. Concrete should be placed in a manner that will permit the most thorough compacting and should be worked and spaded into all recesses of the forms. Concrete should be deposited in its final position as soon as possible after mixing and before it has begun to harden. When the work is interrupted so that the last layer of the concrete has hardened before the next can be applied, the upper surface should be left level, roughened, and cleaned, and should then be covered until the work is resumed, at which time the surface should be cleansed of all foreign material and laitance, then drenched with a mortar consisting of one sack of portland cement and two and a half cubic feet of fine aggregate. The concrete should be placed in continuous horizontal layers. Vertical joints should be avoided whenever possible. Concrete should never be placed in running water. In still water a tremie or other apparatus that will ensure the placing of the concrete without separation of the cement and aggregate and the formation of an injurious amount of laitance should be used. Concrete should never be placed in water when it is possible to avoid so doing.

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Arches, Bridge-Floors, Beams and Girders, Reinforced Cantilever-Type Substructure

Proportions: Concrete should be mixed in the proportions of one sack of portland cement to not more than two cubic feet of fine aggregate and four cubic feet of coarse aggregate.

Consistence: Same as under 'Gravity Abutments.'

Placing: Concrete should be placed in a manner to ensure a smooth surface next to the forms and should be spaded thoroughly and worked around the metal reinforcement and into the recesses of the forms. If possible, concrete for an arch-ring should be deposited in a single run. Large arch-spans, where it is impossible to cast the arch-ring continuously, should be divided into transverse sections, care being taken that the bulkheads dividing the sections are placed radially. Concreting should then start at the crown or springing-lines and should be done simultaneously or alternately in such sections as will nearly balance the load and thrust and thus prevent distortion of the form work and supports. If possible, the entire floor should be placed in one day. If not, the dividing line should be made in a vertical plane, perpendicular to the main reinforcing-rods (in slab-bridges at right angles to the axis or roadway and in floors of girder-bridges parallel to that axis). Concrete should be deposited to the full thickness of the floor and should be brought to the surface of the established grade of the bridge-floor. Workmen should not be allowed to walk on the freshly-laid concrete.

Surface Fnish

The top surfaces of all walls, abutments, girders, slabs, hand-rails, and copings should be tamped carefully and thoroughly. The top surface of abutments, hand-rails, and copings should be given a slightly arched contour, obtained by striking off the concrete in the forms with a strike-board cut to give this surface the desired contour. Concrete in floor-slabs that are to serve as the finished road surface should be compacted by rolling with a finishing-roller similar to the Macon concrete-paving roller.† Immediately after the forms have been removed, projections and irregularities on exposed surfaces should be removed and cavities neatly filled with mortar. Enough 1:2 cement-and-sand mortar should be used to fill the cavities, but no plastering should be permitted. All exposed surfaces should be finished to give a smooth and neat appearance, and when specified should be scrubbed or otherwise finished in an approved manner as directed by the engineer. The bridge-floor, after being brought to the established grade and struck off with a template or strike-board, should be finished with a wooden hand-float in such a manner as to compact it thoroughly and produce a surface smooth and free from depressions.

Protection. Surfaces should be protected from sun and wind and the concrete sprinkled in dry weather so that the whole surface is kept wet for a period of at least one week. Floors should preferably be covered with damp earth, which should be kept wet by frequent sprinkling for at least ten days or until thorough hardening of the concrete is ensured.

Temperature Below 35° F. If at any time during the progress of the work the temperature is below, or in the opinion of the engineer will within 24 hours fall to, 35° F., the aggregates and mixing water should be heated and adequate precautions taken to protect the work from freezing for at least seven days.

Hot Weather. Freshly placed concrete exposed to hot weather and strong sunlight should be protected by watering the surfaces frequently and covering for seven days after being placed.

Removal of Forms. No forms should be removed within 48 hours after concrete is placed. Supports for floors, slabs, and bridge-arches should remain in place at least 21 days. When freezing weather occurs the supports should remain in place for an additional time equal to the time the structure has been exposed to freezing temperatures. No extraneous loading should be placed on the concrete before removal of the forms. The bridge should not be opened to traffic until the engineer directs.

Filling Against Walls and Arches. Earth filling against abutment, wing, and spandrel walls should be placed in horizontal layers, avoiding wedge-shaped sections against the walls. Arch-fillings should be deposited in such a manner as to load the arch symmetrically. The filling back of abutments and between spandrel walls should be drained thoroughly by means of drainage lines and scuppers through wing-walls, arch-rings, and piers.

Drainage of Floors. The floors of all slab and girder bridges should be provided with suitable drain-scuppers at frequent intervals.

Coffer-Dams. Coffer-dams should be constructed as nearly water-tight as practicable. No pumping should be permitted inside of foundation-forms while concrete is being placed. Should it become necessary to prevent flooding, a seal of concrete may be deposited in the bottom of the coffer-dam and allowed to set. Methods of depositing concrete must be such as to ensure that there shall be no separation of materials. If closed chutes or troughs are used, these should never be set at so flat an angle that it will be necessary to use a concrete of wetter consistence than that required for best results. Arch-foundations on piling should be enclosed in permanent continuous sheet-piling, having the tops sawed off one foot below low water.

Foundations

Excavation. All footing excavations should be carried down to firm material except where the sub-foundation material is known to be soft enough to require the use of piles or other special treatment.

Load on Footings. The footings shown on plans prepared by the Illinois Highway Commission are spread

†A circular describing this roller and the method of using it can be obtained from Portland Cement Association.

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to such an extent as to make the average bearing on the sub-foundation material not more than 1½ tons per square foot of footing-area. This load is safe for ordinary material such as firm clay, coarse sand, gravel, or even moderately compacted made ground. It is not an overload for confined sand, provided there is no danger of the stream-bed scouring so as to release the sand or undermine the footings. Saturated sand, however, flows readily if unconfined. Sandy stream-beds are frequently subject to local scour which may endanger the foundations. Local scour 8 to 10 ft. below the stream-bed, because of some obstruction such as driftwood or a sharp change in the course of the current, is not uncommon. Scour 20 ft. deep has been known. Abutment and pier foundations in sandy soils should therefore be designed with this danger in mind. Driving piles in sand with the aid of a water jet is not difficult and affords a fairly economical means of providing for such conditions.

Subsoil Tests. When the excavation is carried nearly to the depth called for on the plans, soundings should be made by driving a rod in the bottom of the excavation, or, preferably, test-pits should be dug to determine the character of the underlying material.

Extra Footings. It is not usually economical to carry the footings to a depth greater than 3 ft. more than that shown on the plans, as the contract price for extra concrete in footings is usually high. If firm material cannot be secured at a depth 3 ft. or less below that shown on the plans, it is usually more economical to drive piles.

Bracing Pits. In making excavations under ordinary conditions, the sides of the excavation if vertical, and more than five or six feet high, are apt to cave unless thoroughly braced. It is usually cheaper and undoubtedly safer for the contractor either to excavate in the first place to a 1 to 1 or flatter slope or else to arrange to brace the trench thoroughly.

Piles

Load on Piles. When piles are used, it is good practice to drive a sufficient number to carry the entire load, including live load and weight of bridge complete, so that the abutment will be stable even should scour remove part of the soil from underneath the footing.

Test-Pile. Should circumstances permit, a test-pile may be driven before the piles are ordered. The test-pile should ordinarily be not less than 20 ft. long. During driving, the necessary observations should be made for the determination of its supporting capacity by the Engineering News' formula. Using the results so found, the number and length of piles may be determined.

Pile-Spacing. In planning the position and spacing of the piles, it is well to hold in mind that under ordinary circumstances piles cannot be driven closer than 2½ ft. centre to centre. If attempt is made to drive piles closer than this, the last pile driven is likely to raise all of the piles already driven an amount approximately equal to the displacement of the pile under the hammer. If a greater supporting capacity is required, the footings should be spread in order to accommodate more piles, or else longer piles should be used. Ordinarily, the minimum spacing should not be less than 3 ft. centre to centre. In general, a greater number of piles should be placed under the stream-side than under the land-side of the abutments. Not more than one-half the diameter of the pile should project beyond the neat lines of the abutment wall proper unless the footings are reinforced properly. The piles should extend into the foundation from 6 to 9 in. Concrete should be placed around the tops, bedding them from 6 to 9 in. in the concrete when the work is finished.

Concreting Footings

Inspection of Completed Excavation. An inspector should be on the work when the placing of concrete in the footings is started in order to be sure that the sub-foundation material is satisfactory and that the footing-concrete is properly placed. The bottom of the excavation should be clean and as free from soft material as possible.

Tempering Footing-Concrete. Dry concrete should never be placed in footings, even should the excavation contain considerable water. If concrete is placed dry, it is likely to become wet only on the surface, leaving most of the concrete dry.

Placing Concrete in Footings. If there is trouble from an excessive amount of water draining into the pit, care should be taken to prevent the cement from being washed out of the concrete and carried off with the water removed by the pump. If there are no steel rods to interfere, the footings should be carried forward to the full depth from one end of the trench toward the pump.

Use of Tile. It may be necessary to lay a line of tile around the edge of the excavation to take the water to the end where the suction of the pump is placed. Concrete may then be placed, beginning at the opposite end from the pump-suction, finally stopping the pump and filling the pocket or sump at the point of suction. This layer should be allowed to harden for 24 hours or more before pumping out the excavation again.

Reinforced Footings

Placing. In reinforced concrete footings a layer of concrete should usually be deposited as far as the elevation occupied by the lower bank of horizontal rods. These rods should then be placed with the vertical bars hooked around them and supported temporarily, and the next layer of concrete placed immediately before the lower layer has had time to set. The top rows of bars should then be placed and the footing-concrete completed before any of the concrete hardens, working from one end of the abutment toward the other. If there is much trouble from water in the pit, it may be necessary to support all of the footing-steel rigidly in

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place before any concrete is placed. This is good practice in any case.

Supporting Steel. Projecting ends of reinforcing-bars should be supported rigidly so as to avoid danger of the bond being loosened. This applies particularly to the vertical bars in abutments, wings, and to stirrups in the girders. Thrusting bars to place in concrete that has attained initial set should not be tolerated.

Placing Steel. Care is necessary in placing in exact position footing-bars and the vertical bars that project from the footing as the section of greatest stress in a cantilever type of retaining wall is at the top-surface of the footing and the part of the vertical bars below this section must therefore provide sufficient bond to develop the full strength of the bar.

Falsework

Mudsills. Falsework for supporting the superstructure of concrete bridges should be designed, if on mudsills, so that the sills have a sufficient bearing area to carry the weight of the superstructure without appreciable settlement. Not more than two tons per square foot of bearing area should be permitted for such sills on good material. A higher allowance may be made on firm hard material or gravel. On soft material the bearing pressure should be reduced by increasing the dimensions of the sills, or preferably piles should be driven to support the falsework, or possibly concrete footings placed.

Concrete Falsework-Sills. Contractors frequently find concrete footings for falsework to be advantageous. These may be constructed of lean concrete, but they should have ample area to carry the weight of the falsework and superstructure. Plenty of time should be allowed for the concrete to harden.

Stresses in Falsework. In order that undue deflection or crushing of the caps, stringers, and sheeting for the superstructure-concrete may be avoided, the following stresses should not be exceeded for yellow pine or oak timber.

Fibre-stress in cross-bending, 2000 lb. per square inch.

Crushing across the grain, yellow pine, 600 lb. per square inch.

Crushing endwise of the grain for short blocks or stiff columns, 4000 lb. per square inch.

Long posts must be braced in both directions. The unsupported length in any direction should not exceed 15 diameters of the stick. All of the above stresses should be reduced one-half for green timber and for sapwood.

Natural gas produced in the United States in 1916 amounted to 753,170,253,000 cu. ft., valued at $120,227,468, giving an average value of 15.96c. per thousand feet. Of this amount 235,380,784,000 cu. ft. was consumed by 2,362,494 domestic consumers, and 517,789,489,000 cu. ft. was consumed by 18,278 industrial consumers. About two-thirds of the gas used in the industries is used for manufacturing, and the remainder for generating power.

Industrial Progress

SAFETY RULES FOR QUARRY OPERATIONS*

Slides of Overburden. Where the removal of a heavy covering of soil is necessary, safety demands that two important considerations govern the plan of stripping. (1) Soil is less coherent than rock and cannot be excavated safely from a steep face. The danger of falls or slides may be decreased by avoiding overhanging or unduly steep walls. The conditions of safety are governed by the nature of the material and by other circumstances. A bank which appears safe may on account of rain, or if frozen may when thawed, become dangerous. (2) The stripped rock-surface between the bank and the quarry-pit should be wide enough so that there is no danger of soil falling or bowlders rolling over the edge of the excavation. Serious accidents have resulted from slides of overburden into the quarry-pit. The practice of making stripping-walls almost continuous with quarry-walls is dangerous. If the stripped surface is narrow or if it slants toward the excavation in such a manner that there is a possibility of material falling over the edge, a protecting fence should be maintained along the edge of the pit.

Slides of Rock at the Working-Face. In quarries that produce rock for crushing, lime burning, etc., hand-loading of fragments at the quarry-face necessitates certain risks. When obliged to work at the base of a steep pile, workmen should always maintain a clear way of escape. In some quarries the quarryman picks out certain qualities and sizes of stone and piles them behind him ready for removal by car. Serious and even fatal accidents have resulted from thus building a barrier that prevents escape when a rock-slide takes place.

Danger Around Waste Heaps. A similar danger exists around steep waste-heaps, especially where a roadway passes close to the heap. Blocks may roll down the steep face and injure men or teams that may be working near by or may be passing along the road. Waste rock should be built in a secure protecting-wall on the exposed sides of such heaps.

Dangers of Bench-Quarrying. Where a quarry is carried downward in a series of steps or benches, especially in quarries for the production of cement, lime, or crushed stone, the laborers at the foot of a bench are in danger of rock falling from the bench above them. Methods of deep drilling are not only more efficient, but overcome this danger entirely by eliminating the benches. In many quarries drill-holes are driven 50, 60, or in some cases over 100 ft. in depth, and the quarry worked as a single bench. If a steam-shovel can be used on the shattered mass the danger of falling rock at the working-face is decreased.

Explosives

Both black blasting-powder and high explosives are used extensively in quarrying. Those whose duty it is to work with explosives are urged to obey strictly the rules for storage and handling supplied by the manufacturers with every box or can shipped. Copies of such rules should be posted in prominent places where blasting is done. As few men as efficiency will permit should be allowed to handle explosives. Dynamite deteriorates with age and becomes less sensitive and efficient. Consequently dynamite kept for a long time is dangerous. When a new supply is placed in the magazine, that which remains on hand should be placed to one side and later piled on top of the new explosive in order that the old may be used first. Dynamite and other high explosives containing nitroglycerin may be-

*Abstract from Technical Paper No. 193 of the U. S. Bureau of Mines.

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come frozen during cold weather and should never be cut or used while in this condition, because it is dangerous to handle nitroglycerin explosives when partly thawed. They should be thawed only with proper apparatus and never before a fire, on hot steam pipes, in hot water, or by placing them in the sun. A description of a proper thawing apparatus is given in Bureau of Mines Bulletin 80, 'A Primer on Explosives for Metal-Miners and Quarrymen.' Every man who handles explosives should obtain the bulletin mentioned and become familiar with the rules given therein.

No more explosive than is necessary for a single blast or series of blasts should be taken into the quarry at one time, the remainder being stored at the magazine for use when needed.

Warning Signals. If possible, blasting should be done before or after working hours, when workmen are absent from the quarry. In any case ample warning should be given. In some quarries two whistles indicate small 'pop-hole' shots, and three whistles those of a more dangerous character. If a series of shots are to be fired, warning whistles should be sounded both before and at the end of the blasting, in order that there be no premature leaving of shelter.

Shelters. Safe shelter should be sought for every blast. The men should be protected from flying fragments and also have overhead protection from small pieces, which may be blown high in the air and fall almost vertically. There is danger, especially in granite quarries, of small fragments being projected to so great height that men leave their shelter before these fragments fall. Semicircular cone-shaped shelters of sheet metal are recommended. If provided with a ring at the top, they may be easily placed in any desired position by means of the quarry or yard derrick without delaying the work.

Firing Shots. The man who loads should fire. No one else should be allowed to touch the switch or firing machine. Accidents have resulted from misunderstandings and confusion of orders when one man loads and another one fires. One method of firing cannot be too strongly condemned. It consists in filling a hole with powder and then pouring a trail of powder over the rock surface for a distance of 5 or 6 ft. By scratching the rock surface with a steel drill the trail is ignited and quickly fires the charge. The time allowed for seeking shelter averages from two to three seconds. No further comment is necessary. Plenty of time should be allowed before approach to the danger zone after firing, especially if fuse is used. A delayed discharge may smoulder several minutes. Careful investigation should be made of misfires and incompletely detonated charges.

Procedure in Case of Misfires on Repeated Shots. A source of danger in making subsequent shots is in loading a second charge into the hole too soon after the explosion has taken place. The rock may be hot, or burning fragments of fuse may remain in the hole.

In case of misfire, if fuse alone was used and no detonator, a charge of powder may be removed after careful removal of the stemming, both stemming and powder being thoroughly wetted during the process of removal, but if a detonator is present in the charge its removal should not be attempted. Charges of dynamite should never be removed. The process is too dangerous. A second hole should be drilled not less than 2 ft. away; and after blasting, careful search should be made for pieces of dynamite which have not exploded.

Machinery

Many of the accidents that are attributed to lack of care, or to chance, may be avoided by insisting upon the observance of a few sensible rules in machine design.

Angular moving parts or projections should be as few as possible. Such projections as cannot be readily eliminated, as well as eccentrics, set-screws, gears, cams, bolts, chains, sprockets, keyways, belts, connecting-rods, cranks, and other dangerous revolving or moving parts actuated by power shall be guarded and protected in such manner that the clothing of an attendant cannot become entangled. Quarry operators can do much to promote safety by specifying such requirements for their new machinery. Belts should be protected adequately. For belts in remote places a pipe-railing is sufficient. Belts in more exposed places should be protected with guards of wire netting, made from No. 12 gauge wire and of not more than 1½-in. mesh. Strong supports are necessary for snatch-blocks or sheaves for the use of cables subjected to intense strain. If such supports break, any one standing inside the bend of the cable is almost sure to sustain serious injury, as the cable may fly with such force and speed that escape is impossible. If eye-bolts are used they should be so placed that the strain is along the axis of the bolt, not across it.

Systematic Inspection of Equipment. Deterioration and resulting weakening of equipment demands constant vigilance. Repeated strains, wear, rust, decay, or displacement of parts may cause dangerous breakages unless observed and the defects corrected. A plan of systematic inspection required by the Vermont Marble Co. is to be highly recommended. Inspectors, who are capable engineers, are required to examine carefully and report on all equipment at stated intervals. Their duty is not to gloss over defects but to uncover them. A breakage due to defective equipment which had been reported as safe would be sufficient reason to accuse the inspector of inefficiency or carelessness, so that it is to his interest to detect and report all defects immediately. For a large company operating many quarries, one or even several engineers may be required to give their entire time and attention to this duty. It is greatly to be desired, however, that smaller companies operating but one or two quarries should follow the same principle. It is important that the inspection should be systematic, and at a set time, for example, every day or every second day for hoists, cables, slings, and chains, and every week or every two weeks for masts and booms. Inspection should be complete, touching every detail of equipment. The hoist-man is the logical man in small quarries to conduct such examinations.

In this connection quarry operators should encourage their workmen to point out defects or dangers. Many laborers or machine-runners are intelligent and keen observers, and their suggestions should be welcomed. They may, however, hesitate to report dangers, considering such action to be outside their duties, and so should meet encouragement and not rebuffs when they offer suggestions. Some even consider it an act of cowardice to report dangers, or to refuse to work where dangers exist. This erroneous idea is fortunately giving way to more sane conceptions of safety. The workman that reports a weakness or defect that is a menace to safety is performing a real service to his fellow-workmen, his employer, and himself.

Hoists. Gears should be inclosed with an iron or wooden railing. Exposed cables, especially where they pass through sheaves, should be covered. Hoist-sheds should be situated only at points free from the danger of flying rock. Instances have been noted where holes have been broken through roofs and walls by masses of flying rock. The danger to the hoist-man is increased if the shed contains boilers or steam-pipes. Accident to the hoist-man, or distraction because of the danger of accident may jeopardize the safety of quarrymen whose welfare is dependent upon his operations.

Derricks. Steel derricks are probably safer than those made of wood. The latter may, however, be kept in safe

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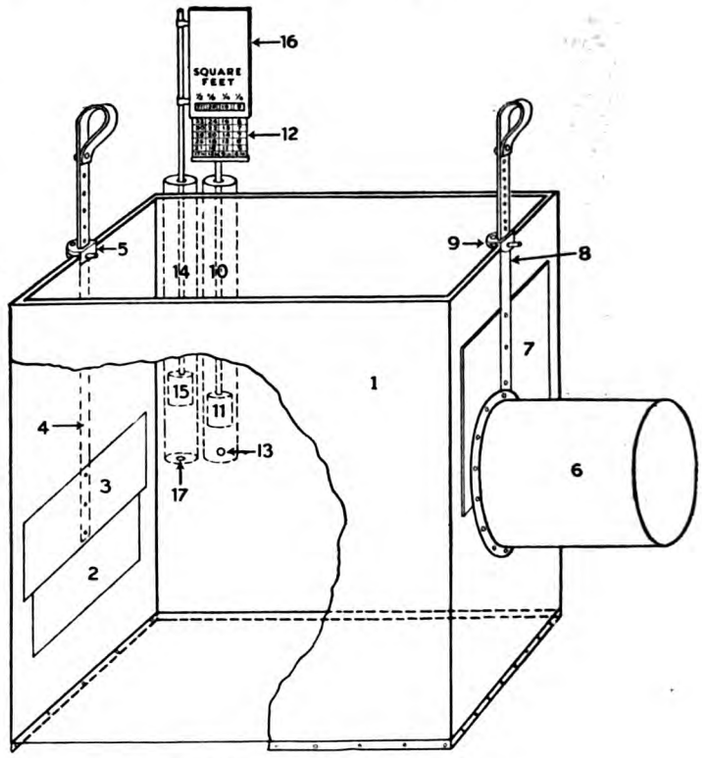
condition by thorough painting and by frequent inspection, especially around castings and bolt-holes where decay is most likely to begin. Safety demands a large number of supporting guys. For derricks having a lifting capacity of 25 to 40 tons, ten to fourteen 1¼-in. iron or steel guys are regarded as sufficient. The efficiency of the guys depends upon anchorage and splicing. When properly constructed the following anchors are regarded as safe: Ring-bolts in solid rock, buried timbers when not in the ground too long, trunks of growing trees, well-secured posts or reinforced-concrete piers. An improved arrangement of guys is used by the Vermont Marble Co. on some of its newer derricks. Instead of spacing 12 guys regularly they are placed in 4 groups of 3 each. The advantage lies in the fact that 4 large safe concrete piers may be constructed at a smaller cost than 12 small and possibly unsafe ones. The need of sufficient support cannot be over-emphasized. It is not uncommon to hear of a derrick falling. When this happens men are exposed to the danger of falling masts, boom, and the gear attached, and in addition to the derrick itself every guy is a serious menace. Occasionally a supporting guy is stretched from the top of one mast to the top of another, or even a series of three or four masts connected in this manner. Such interdependence is not to be recommended. Strains on the different masts may occur in the same direction at the same time and thus multiply the strains on a single guy. In joining or securing the ends of cables, clamps are to be recommended rather than splicing, because of greater reliability.

Cable-Attachments. Many accidents are caused by falling rock during the process of hoisting. Such falls may be due to weak hoisting-equipment or to faulty attachment. Assuming that the equipment is sufficiently strong, safety in hoisting depends largely upon the method of cable-attachment to the block. The three common modes of attachment are grab-hooks, chains, and cable-slings. Grab-hooks are commonly used in sound rock. They should never be used in rock having planes of weakness such as mica bands, as the weight of the suspended lower part of the block may cause a separation along such a plane, allowing a mass to fall. Even in seemingly sound rock an unseen fracture may cause a similar fall of rock. The mass must be balanced with care or it may rotate and cause the hooks to slip. There is constant danger of a corner breaking out, allowing the block to fall. This danger is lessened if grab-hook holes are properly made. A common error is to assume that deep holes insure greater security than shallow ones. If holes are made too deep the danger is increased, as the pressure falls on the bend of the hook and may cause the corner of the block to chip off. The hole should be deep enough to give a secure hold but the weight should fall on the tip of the hook resting in the bottom of the hole. The use of grab-hooks is not to be recommended. A chain passed completely around a block is safer than grab-hooks. There is little chance of a block falling as long as the chain holds; there is, however, the ever-present danger that the chain may break. A chain is of uncertain strength and breakage is usually unexpected. A weak link cannot readily be detected, as defects in a chain are for the most part invisible. An instance is reported of a link breaking and flying with such force that it killed a workman 50 ft. away. If a chain is used, it should be massive enough to bear strains far beyond those ordinarily required of it, and it should have frequent and careful examination for evidence of defects. The best and safest mode of attachment is by steel-cable slings. The great advantage of steel-cables is the ease with which flaws or weakness may be detected. A cable consists of many strands and a flaw in any one strand does not materially weaken the whole group. Also, there is less difficulty in balancing blocks when double loops are used.

THE BURNHAM SUBMERGED ORIFICE

In the early days of irrigation, when land and water were both comparatively plentiful, little or no attempt was made to measure the water used. On most systems the water-users paid a fixed amount per acre per year and the water from each canal was divided among the users by various rough-and-ready methods. While this system is still followed in some localities, most irrigation-water is now sold on the basis of the quantity used, just like any other commodity. One reason for clinging to the older systems has been the lack of simple devices for measuring water in the quantities used by the average water-user. There are many devices for measuring water with a reasonable degree of accuracy, but, as a rule, the use of these devices requires a greater knowledge of mathematics and hydraulics than most water-users and ditch-tenders possess. To supply this need for a simple easily-read measuring device, the Utah Corrugated Culvert & Flume Co., of Woods Cross, Utah, has perfected the Burnham Submerged Orifice.



THE BURNHAM SUBMERGED ORIFICE

This device, which is shown in the figure, consists of a galvanized sheet-iron tank (1). The bottom of this tank may be either metal or concrete. At 2 is an orifice, the size of which can be regulated by an adjustable slide, which can be raised or lowered an inch at a time, and which is held in place by a stem and pin. A 6 is the discharge-pipe. The lower edge of this discharge-pipe is $\frac{1}{16}$ in. above the upper edge of the orifice, which ensures that no water will pass through the pipe until the orifice is submerged completely. The slide for the orifice can be raised or lowered ¼ in. at a time. At 10 is a stilling-well for the water within the tank, and at 14 a stilling-well for the canal-water, both equipped with rods and floats, arranged so that the head on the orifice can be read directly. With this equipment, the dimensions of the orifice and the head may be read directly without computation. Charts are furnished with each device by which, given the quantities above, the discharge in either second-feet or miners' inches can also be obtained directly without computation.

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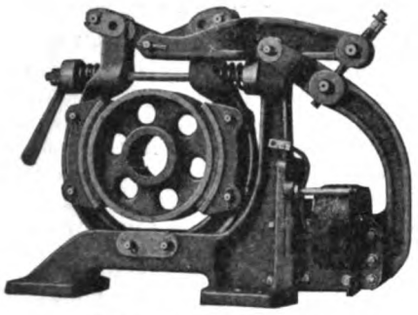
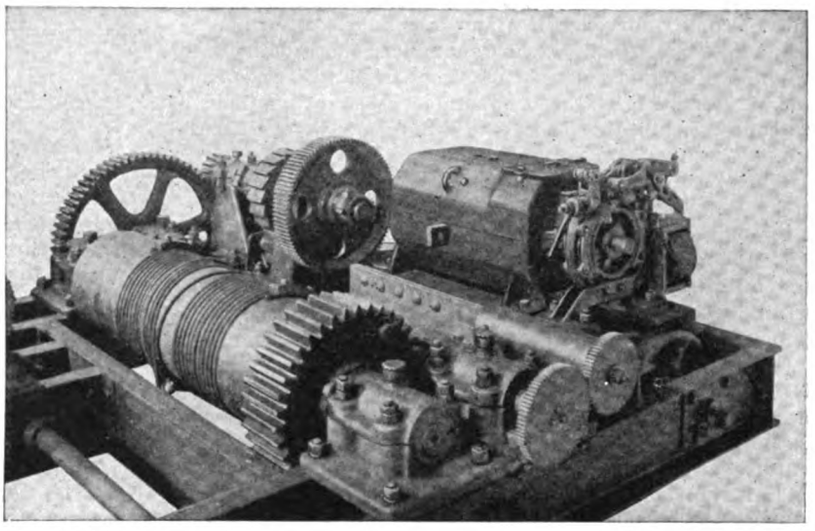
MAGNETIC BRAKES

The principle of the type of magnet which has been so successfully incorporated in the design of magnetic controllers by the Westinghouse Electric & Mfg Co., of East Pittsburgh, Pennsylvania, has been employed by that company in a new design of magnetic brakes developed for use with mill, crane, and hoist-motors. The use of a clapper-type magnet eliminates all moving parts within the coil and the consequent wear, sticking, or damage to insulation.



BRAKES AND BRAKE-WHEEL



MAGNETIC BRAKE APPLIED TO WINCH

The modified and improved 'type A' alternating-current brake with which the trade is already familiar and the new 'type B' direct-current brake are similar in operation and have common parts throughout except for the armature-lever and magnet. These brakes are characterized by the quickness of their operation. They respond almost instantly, releasing when the power is applied and setting when the power is cut off. This is due to the design of the operating magnet, which gives a high initial pull and a small distance of travel (¼ to 1 in.). Their operation is similar. When voltage is impressed on the motor the magnet is energized and the magnet-armature level overcomes the pressure of the compression springs through a toggle and releases the brake-shoe grip upon the brake-wheel. While the magnet remains energized the brake-wheel is allowed to rotate freely. As soon as the current is shut off from the motor the brake-magnet releases and the compression springs force the shoes against the brake-wheel, bringing the motor quickly and smoothly to rest without shock or jar. The compression exerted by the springs can be adjusted easily so that any holding or retarding torque up to the full capacity of the brake can be obtained for equal-braking effort for both directions of rotation. Simple means for making adjustment for shoe-wear are provided. In case adjustments for shoe-wear should be neglected a safety feature has been introduced so that the brake does not fail to hold the load, but the magnet will not release the grip on the brake-wheel. This insures proper brake-operation and the elimination of accidents due to the slippage of the brake-wheel. The simplicity and accessibility of the few parts of these brakes are shown in the accompanying illustrations. An interesting description, interspersed with many engravings, is given in the manufacturer's leaflets 1750 and 1751 on the types A and B brakes, respectively. Copies of these leaflets may be obtained at any of the branch-offices of Westinghouse Electric & Manufacturing Company.

CONSTRUCTION OF PERMANENT SMOOTH ROADS BY THE USE OF ASPHALTUM

Oiled roads have had, in the past, a tendency to break down in places and become uneven after a short time. The trouble was that earlier road-oils contained only a small proportion of asphaltum. The tests made by the Standard Oil Co. have proved that asphaltum offers much greater resistance to traffic and the elements than ordinary road-oil. Engineers are recognizing this fact and are using Calol Asphaltum (E grade) in their highway work. The result is that the smooth road, instead of being a total stranger to the motorist, is becoming a well-known friend.

Book Review

Chemical Analysis of Iron. By A. A. Blair. 8th edition. Pp. 318, ill., index. J. B. Lippincott Co., Philadelphia, 1918. For sale by 'Mining and Scientific Press.' Price, $4.

Since 1912, when the last edition appeared, there have been many improvements in the analysis of iron ore, limestone, coal, coke, clay, sand, iron, steel, and alloy metals. Since 1914, steel and alloy metals have become highly important, and a handbook containing up-to-date methods of analysis is welcome. In the handling of 60,000,000 tons of iron ore, manufacture of 35,000,000 tons of steel, and hundreds of thousand tons of alloy steels in a year in this country, it might be said that the whole business is based on careful analyses, which must be performed rapidly. The first 54 pages of the new book describes the apparatus and reagents used in determinations; the remainder is devoted to methods of analysis. Rapid methods are given in many cases, including the important elements sulphur, silicon, phosphorus, and manganese. The determination of carbon in iron and steel occupies 45 pages, including description of various apparatus needed. For those interested in the rarer minerals, the analysis of tungsten, vanadium, molybdenum, and chromium in steel is of value, also ferro-tungsten, ferro-molybdenum, ferro-vanadium, ferro-chrome, ferro-silicon, and ferro-manganese. Iron-ore analysis receives 43 pages, and is fully discussed; while fuel and fluxes in blast-furnace reduction are given due attention. A feature of the analytical work is a good sketch of nearly all apparatus used, a great aid in following each method. Generally, we consider this work timely and valuable.

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Personal

F. T. Robson, Captain 307th Engineers, has arrived in England.

E. D. Perry has been appointed city engineer of Santa Cruz, California.

Charles C. Moore has been appointed chairman of the California State Council of Defense.

C. P. Jensen has announced his candidacy for the office of county surveyor of Fresno county, California.

Harlan D. Miller has announced his candidacy for the office of county surveyor of Alameda county, California.

A. Van der Naillen, Jr., has announced his candidacy for the office of county surveyor of Alameda county, California.

H. J. Brunnier has been appointed assistant engineer of the concrete-ship division of the Emergency Fleet Corporation.

Charles Gilman Hyde, professor of sanitary engineering at the University of California, has received a commission as Captain in the sanitary corps of the National Army.

E. W. Mason, formerly general manager for the Western Pacific Railroad Co., has received a commission as Major in an engineer regiment. He has been succeeded by **J. S. Spelman.**

Thomas S. Williams, formerly member of the State Board of Harbor Commissioners of California, has resigned. He has been succeeded by H. H. Cosgriff, formerly secretary of the Board.

Mott Sawyer, formerly superintendent of the Idaho and Columbia division of the Chicago, Milwaukee & St. Paul Railroad, has received a commission as Colonel of a railroad engineering regiment.

W. C. Sloan, formerly superintendent of the Pasco division of the Northern Pacific Railway, has received a commission as Captain in an engineer regiment. He has been succeeded by **James Shannon.**

W. M. Stillman, formerly assistant superintendent of the Stockton division of the Southern Pacific Railroad, has received a commission as Captain in the 31st Engineers, which is a railroad-operating regiment.

W. H. Lynch, engineer for the U. S. Office of Public Roads has recently completed a report on road improvement in Fresno county, California, and is now engaged in similar investigations in Sonoma county.

T. R. Harrold has announced his candidacy for the office of county surveyor of Fresno county, California. Mr. Harrold was deputy county surveyor for several years and was recently appointed county surveyor, succeeding the late Scott McKay.

An article by **Charles Evan Fowler** on 'The Longest Possible Bridge-Spans' in the 'Scientific American' for June 1, describes the proposed bridges across San Francisco bay and across the Hudson river at New York as well as several existing bridges.

Max Thelen, formerly president of the State Railroad Commission of California, has resigned to become surveyor of supply contracts for the War Department, with headquarters at Washington, D. C. Governor Stephens has not appointed a successor to Mr. Thelen as yet. **Edwin O. Edgerton** has been elected president of the Commission.

H. G. Butler, formerly assistant chief engineer for the California State Railroad Commission, has been appointed head of the newly-created department of power administration of the Commission. Mr. Butler will have charge of the distribution of power to consumers, also of determination of priority questions, should the adoption of a priority-list be found necessary.

O. W. Moore, formerly assistant superintendent for the South San Joaquin irrigation district, has resigned to take a position on a large irrigation project in Alberta, Canada, which is being handled by the Canadian Pacific Railroad. This project is in charge of **A. Griffin,** formerly chief engineer for the South San Joaquin irrigation district. **Charles Shafer** has been appointed to succeed Mr. Moore as first assistant superintendent and **F. A. Darling** has been appointed second assistant superintendent.

R. E. Collom, formerly deputy oil and gas supervisor for the State Mining Bureau, with headquarters at Santa Maria, has been appointed chief deputy supervisor, with headquarters at San Francisco. He has been succeeded by **H. W. Bell,** who has been inspector and engineer for the Bureau for some time past, both at Coalinga and Santa Maria.

Commercial Paragraphs

The Westinghouse Electric & Manufacturing Co. has purchased the property, business, and good-will of the Krantz Manufacturing Co., Inc., of Brooklyn, New York, manufacturers of safety electrical and other devices. The supply department of the Westinghouse company will act as exclusive sales-agent for the products of the Krantz company, whose business will be continued under its present name. H. G. Hoke will represent the Westinghouse company at the Krantz factory.

The Tacoma Dredging Co., which has done a large amount of dredging and other construction work in the North-West, including a large part of the building of Camp Lewis, has recently entered the California field, doing work for the Imperial irrigation district near El Centro, California. The company has just launched a dredge-scow 90 ft. long, 40 ft. beam, and 6 ft. deep, in 18 days after the work was started. The company is also to re-build three other dredges for more efficient service and will also do considerable other work for the district. This work has been under the direction of C. A. Strong, general superintendent for the company. Beebee & McWethy, First National Bank Bdg., San Francisco, are the local representatives of the company.

The Ingersoll-Rand Co. has recently issued the following bulletins:

Form 4039, an 8-page bulletin on the Leyner shank and bit-punch for punching holes in bits and shanks of hollow drill-steel.

Form 901, a 4-page folder describing the Little David 'pneumatic tools,' including tables of sizes and capacities.

Form 9028, an 18-page catalogue of equipment for sugar factories and refineries. There is also a special Spanish edition of this catalogue.

Form 9010, a 4-page folder describing the 'Sergeant' ticket-cancelling box.

Form 901-1, a single sheet describing the 'Little David' calking machine.

Form 888, a 4-page folder describing the 'Little David' evaporator-tube cleaner.

Form 876, a single sheet describing barometric condensing-plants.

Form 883-A, a single sheet describing class FP steam-engines. These engines are of the horizontal centre-crank type with piston-valves.

Form 3015-1, a 4-page bulletin describing portable mine-car air-compressors.

NEW PUBLICATIONS

The California State Mining Bureau has recently issued a revised map of the Whittier-Fullerton oilfield, including the Whittier, West Coyote, and Montebello districts. The map is 27 by 32 in. and is on a scale of 2000 ft. to the inch. The price is 50 cents.

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Construction News Summary

STREET AND ROAD WORK

Astoria, Ore.—Bids will be received until July 6 by county clerk for grading 3300 lin. ft. of the Warrenton Cut-off road.

Contract for clearing and grading the Youngs River Falls road, 2¼ miles, has been awarded to the Warren Construction Co., Portland, for $0.59 per cu. yd., or $25,025.80.

Contract for construction of 2900 lin ft. of the Jewell road has been awarded to P. P. Gaston for $1392.90.

Canyon City, Ore.—Bids will be received until July 3 by county clerk for grading, draining, and macadamizing about five miles of the John Day highway between John Day and Prairie.

Auburn, Wash.—Contract for construction of concrete pavement on First street has been awarded to Kaiser Paving Co., Everett, the only bidder, for $12,014.

Berkeley, Cal.—Following bids were received for improving streets adjacent to University campus: Clark & Henery Construction Co., combined curb and gutter, $0.95 per ft.; concrete curb, $0.50 per ft.; grading, $0.039 per sq. ft.; asphalt pavement on 5-in. concrete base, $0.278 per sq. ft.; catch-basins and curb-inlets, $75 each. Bernard Ransome bid $0.98, $0.61, $0.04, $0.263, and $75 for the same work. Oakland Paving Co. bid cost plus 10%, cost not to exceed either $19,500 or $21,500, according to conditions.

Blythe, Cal.—Contract for construction of 20 miles of macadam pavement in district No. 5, which had been awarded to Johnson-Shea Co., has been rescinded because of disapproval of project by Capital Issues Committee, and work will be postponed until after the War.

Bremerton, Wash.—R. H. Travers, Seattle, was low bidder at $55,170 for construction of concrete pavement on several streets. J. A. Fletcher bid $56,149 and F. N. Badalato $57,940.

Chehalis, Wash.—Contract for grading and draining 1.8 miles of the Park highway has been awarded to John Ward, Chehalis, for $5757. Jarvis & Burkheimer bid $6340 and Allred & James bid $5911.

Contract for construction of sidewalks on Folsom street has been awarded to Albers & Son, Chehalis, for $1934.94.

Colfax, Wash.—Contract for construction of 3¾ miles of highway from Tekoa north to the Spokane County line, 3¾ miles, has been awarded to Thomas & Bragg, Colfax, for $43,461. Other bidders were J. W. Hastings, $44,520; Pethrem-Blai Co., $44,800.

Contract for construction of permanent highway No. 2 has been awarded to Mitchell Bros., Spokane, for $88,000.

Colusa, Cal.—Bids will be received until July 3 by T. D. Cain, county clerk, for grading and surfacing part of the Arbuckle-College City road.

Corona, Cal.—Contract for improvement of North Main street has been awarded to Johnson-Shea Co., Riverside.

Ephrata, Wash.—Contract for construction of permanent highway No. 10, three miles, has been awarded to Northwest Paving Co. for $14,404.

Contract for construction of permanent highway No. 12 has been awarded to C. G. Betts for $5534.

Eureka, Cal.—Poland & Moore were the only bidders at $57,350 for construction of 10½ miles of the Bull Creek-Mattole road. Bid was rejected because too high.

Fairfield, Cal.—Board of Supervisors have appropriated $10,000 for construction of road connecting Grisly island with the State highway.

Fresno, Cal.—W. H. Lynch, engineer for the U. S. Office of Public Roads has recommended the construction of county highway system after the War, but no extensive construction at the present time. The proposed system would comprise 170 miles of highway and would cost $2,393,192, including the county's share of the cost of construction of the State highway lateral from Hanford to San Lucas by way of Coalinga.

Contract for improvement of Howard street has been awarded to Thompson Bros., Fresno, at 2.5c. per sq. ft. for grading, 21.5c. per sq. ft. for bitulithic pavement on concrete base, 50c. per ft. for concrete curbs, 13c. per sq. ft. for concrete sidewalks, and 18c. per sq. ft. for concrete gutters.

Los Angeles, Cal.—George H. Oswald, O. T. Johnson Bdg., Los Angeles, was low bidder at $303,000 for construction of 14 miles of oil-macadam highway in the Antelope valley between Lancaster and Redman. George A. Rogers and Fred Hoffman were the only other bidders at $369,000.

Contract for grading and oiling Fountain avenue and adjacent streets has been awarded to W. Liddington, 420 East 60th street, Los Angeles, for $11,620.74.

Contract for grading, oiling, and construction of concrete curbs, sidewalks, and gutters on Carillo street has been awarded to M. S. Cummings, 1302 West 22nd street, Los Angeles, for $16,081.70.

Los Angeles, Cal.—Contract for construction of asphaltic-macadam pavement on concrete base on Cherry avenue has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles,; for $39,281.76.

Martinez, Cal.—Following were the unit prices named by A. J. Grier, 525 Market street, San Francisco, who was awarded contract for completion of division No. 4 of county highway system near Pittsburg; county furnishing materials: concrete pavement, $5.70 per cu. yd.; placing wire-mesh reinforcements including hauling from railroad $0.02 per sq. ft.; excavation, $0.90 per cu. yd.; overhaul, $0.03, a total of $4921.80. O'Brien Bros. bid $7.43, $0.01, $0.60, and $0.03 for the same items.

Following were the unit prices named by A. J. Grier, who was awarded contract for construction of the Loveridge road near Pittsburg, county furnishing materials: concrete pavement, $5.50; placing and hauling wire-mesh reinforcement, $0.015 per sq. ft.; embankment, $1.10 per cu. yd.; overhaul, $0.03, a total of $6307.66. O'Brien Bros. bid $7.40, $0.01, $0.60, and $0.03, and Western Construction Co., $6, $0.015, $1.40, and $0.03 for the same items.

Martinez, Cal.—O'Brien Bros., Martinez, were the only bidders and were awarded contract for completion of division No. 6 of county highway system at $7.50 per cu. yd. for concrete pavement, including hauling materials, $0.01 per sq. ft. for wire-mesh reinforcement, and $1.10 per cu. yd. for excavation. County will furnish materials.

Missoula, Mont.—Bids will be received until July 12 by District Engineer, U. S. Office of Public Roads, for clearing, grading, and construction of bridges and culverts on the Sheep Creek National Forest road, 5 miles.

Bids will also be received until the same time for construction of section 2 of the Yaak Valley National Forest road, 10.5 miles.

Mt. Vernon, Wash.—Contract for paving section 1 of the part of the Pacific highway between Mt. Vernon and the Snohomish County line, 4½ miles, has been awarded to Kaiser Paving Co., Everett, for $83,597.54, using 4-in. bitulithic pavement. The following bids were received for concrete pavement on the same work: Kaiser Paving Co., $96,372.02; R. M. Hardy, $96,314.53; Two Miracle Concrete Co., $102,595.20; James & Ward, $110,745.90.

Contract for paving section 2, 3½ miles, has been awarded to Kaiser Paving Co. for $65,163 for concrete pavement 6 in. thick. Other bidders were R. M. Hardy, $70,908.12; James & Ward, $71,549.23.

Contract for construction of 1¾ miles of concrete pavement on the Pacific highway between Burlington and the Skagit river has been awarded to C. L. La Plant, Sedro Woolley, for $27,231.38. Other bidders were R. M. Hardy, $28,107.40; Kaiser Paving Co., $32,159.46; James & Ward, $39,450.

Oakland, Cal.—Contract for improvement of 29th avenue between 14th and 16th streets has been awarded to Hutchinson Co. at the following unit prices: grading, 1.25c. per sq. ft.; concrete curbs, 49c. per ft.; concrete gutters, 16c. per sq. ft.; oil-macadam pavement, 10c. per square foot.

Contract for improvement of Fleming avenue and Birdsall avenue near 55th avenue has been awarded to Hutchinson Co. at the following unit prices: grading, 4.5c. per sq. ft.; concrete curbs, 60.3c. per ft.; concrete gutters, 18c. per sq. ft.; oil-macadam pavement, 12c. per square foot.

Contract for improvement of Morcom avenue near Birdsall avenue has been awarded to Hutchinson Co. at the following unit prices: grading, 3.55c. per sq. ft.; concrete curbs, 45c. per ft.; concrete gutters, 15c. per sq. ft.; oil-macadam pavement, 10c. per square foot.

Contract for construction of concrete pavement on Boehmer street near 23rd avenue has been awarded to

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Western Construction Co., at the following unit prices: grading, $0.02 per sq. ft.; 6-in. concrete pavement, $0.18 per sq. ft.; redwood header-boards, $0.10 per foot.

Okanogan, Wash.—Bids will be received until July 8 by J. D. Hubbard, county clerk, for grading, draining, and surfacing permanent highway No. 3-B.

Olympia, Wash.—Bids will be received until July 8 by State Highway Commission for construction of 6.3 miles of concrete pavement on Pacific highway between Lacey and Nisqually in Thurston county.

G. N. Adams, Union, was the only bidder for construction of 2.6 miles of State highway from Clifton to Union. Bid was rejected because too high.

Porterville, Cal.—Contract for paving several streets has been awarded to Concrete Pipe & Construction Co., Porterville.

Portland, Ore.—Bids will be received until July 10 by U. S. Forest Service for construction of Pacific highway in Cow Creek canyon in Douglas county, 9.7 miles. Estimated cost is $157,000, of which the Federal Government will pay $67,000, the State $67,000, and the county $23,000.

Following bids have been received for county highway work: Derby street, Warren Construction Co., $27,154.22; United Contracting Co., $30,660; Oskar Huber, $39,298.01. Capital highway, Warren Construction Co., $6221.52; Oskar Huber, $6493.99; United Contracting Co., $6760.93. Division street, Warren Construction Co., $17,635.33; Oskar Huber, $18,720.46. 82nd street, Warren Construction Co., $45,134.80; Oskar Huber, $47,912.66. Foster road, Warren Construction Co., $16,366.96; Oskar Huber, $17,374.38.

N. A. Jones was the only bidder at $34,000 for construction of the Lake Quinault road under the Federal Aid Road Act. Engineers' estimate was $24,000.

Portland, Ore.—Bids will be received until July 17 by District Engineer, U. S. Office of Public Roads, Broadway-Yamhill Bdg., for clearing, grading, and construction of bridges and culverts on the Ochoco Canyon road in Crook county, 9.5 miles.

Redwood City, Cal.—Following bids were received for oiling streets of Wellesley park: A. H. Kopperud, $0.0248 per sq. ft.; Brush-Howard Co., $0.0325; Western Construction Co., $0.03625.

Richmond, Cal.—J. E. Staniger was low bidder at $1757.93 for paving the crossing of 6th street and the Santa Fe railroad. L. L. Page bid $1892.62.

Contract for grading and paving the inner harbor business blocks has been awarded to Fred Meyers, 120 23rd street, Richmond, for about $24,000.

Sacramento, Cal.—Bids will be received until July 8 by State Highway Commission for the following State highway work:

In Alameda county between Overacker's Corner and the southerly boundary, 8.4 miles, to be paved with concrete.

In Monterey county between the southerly boundary and a point 3 miles north-westerly from Bradley, 10.2 miles, to be paved with concrete.

In Tehama county between Red Bluff and the northerly boundary, 12 miles, to be surfaced with gravel, 15 ft. wide.

Contract for improvement of two blocks on 20th street has been awarded to Clark & Henery Construction Company.

Sacramento, Cal.—M. Blumenkranz, Stockton, was low bidder at $82,130.50 for construction of 6.4 miles of state highway in Butte county between Oroville and the Shippee road, including a reinforced concrete bridge across the Northern Electric tracks. W. A. Bechtel bid $94,960 and A. J. Fairbanks, $97,528. Engineers' estimate was $66,-446.60.

White & Gaskill, Long Beach, were low bidders at $128,-678 for construction of 14.9 miles of state highway between Merced and the easterly boundary of Merced county. Rogers Bros. bid $139,216.80. Engineers' estimate was $97,281.95.

J. P. Moffitt, San Francisco, was low bidder at $72,296.70 for construction of 15 miles of state highway in Lassen county between Coppervale and Susanville. F. Rolandi bid $87,572 and A. J. Fairbanks, $95,057.80. Engineers' estimate was $66,827.08.

Rogers Bros., Los Angeles, were the only bidders for construction of 8 miles of state highway in Monterey county between San Ardo and a point 3 miles south of San Lucas. Engineers' estimate was $58,851.48.

No bids were received for construction of 7.4 miles of highway in Humboldt county between Beatrice and Eureka, 11.7 miles of highway in Tehama county between the southerly boundary and Las Molinos, nor for 12.5 miles of highway in Butte county between Biggs and Nelson.

Detailed figures regarding the state highway work, bids for which are to be received until July 8 by State Highway Commission, are now available.

The work in Alameda county between Overacker's Corner and the southerly boundary requires 18,000 cu. yd. excavation, 334 ft. 12 to 24-in. corrugated pipe, 220 cu. yd. concrete in culverts and monuments, 11,100 cu. yd. concrete in pavement, 4900 ft. guard-rail, and 110 monuments. State will furnish reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate.

The work in Monterey county between the southerly boundary and a point 3 miles north of Bradley requires 51,300 cu. yd. excavation, 2161 ft. corrugated pipe, 554 cu. yd. concrete in culverts and monuments, 9920 cu. yd. concrete in pavement, 8850 ft. guard-rail, and 151 monuments. State will furnish reinforcing-steel, cement, sand, coarse aggregate, and corrugated pipe.

The work in Tehama county between Red Bluff and the northerly boundary requires 16,000 cu. yd. gravel surfacing. State will furnish gravel.

Salt Lake City, Utah.—Wattis & Samuels, Ogden, were low bidders for construction of six blocks of concrete pavement in Mount Pleasant at $9875.08 for 18-ft. pavement, and $10,814.68 for 20-ft. pavement.

San Bernardino, Cal.—Following bids were received for highway work in district No. 5: M. R. Co., Inc., Los Angeles, $94,420; Johnson-Shea Co., Riverside, $95,710; Rogers Bros. Co., Los Angeles, $129,910.

San Diego, Cal.—Contract for grading and construction of concrete-pipe culverts on the Otay Mesa road has been awarded to H. G. Fenton, McNeece Bdg., San Diego, for $4968. Other bidders were M. D. Goodbody, $5500; Henry Galbraith, $8584; John Engebretsen, $9986; W. E. Kier Construction Co., $11,600; W. E. Hall Construction Co., $12,492.

Fairchild-Gilmore-Wilton Co., Los Angeles, was the only bidder at $6537.60 for paving 15th street and E street.

San Francisco, Cal.—Following contracts have been awarded for street work:

Boyce street near Geary to J. J. McHugh at $0.25 per ft. for re-setting granite curbs, $0.47 per sq. ft. for basalt-block pavement, $0.50 per sq. ft. for basalt-block gutters, and $1.25 per ft. for granite curb.

15th avenue between Balboa and Cabrillo streets to State Improvement Co. at $0.134 per sq. ft. for concrete sidewalks.

Lobos street between Capitol and Plymouth avenues to Fay Improvement Co. at $0.74 per ft. for concrete curbs and $0.2188 per sq. ft. for asphalt pavement.

Wheat street between Paul avenue and Salinas avenue to Flinn & Treacy at $0.90 per ft. for concrete curbs, $0.30 per sq. ft. for asphalt pavement, and $0.44 per sq. ft. for brick pavement.

Following bids were received by Board of State Harbor Commissioners for paving on the Embarcadero: J. J. McHugh, $18,799; Raisch Improvement Co., $19,145; Fay Improvement Co., $21,225; Eaton & Smith, $21,338; Blanchard-Brown Co., $21,608.80; H. Crummey, Inc., $24,348.50.

Contract for improvement of Diamond street near Surrey street has been awarded to Flinn & Treacy at $0.28 per sq. ft. for asphalt pavement and $0.48 per sq. ft. for basalt-block pavement.

Contract for improvement of Mendell street between McKinnon and Newcomb avenues has been awarded to Flinn & Treacy at the following unit prices: concrete curbs, $0.75 per ft.; asphalt pavement, $0.245 per square foot.

Santa Ana, Cal.—Contract for paving part of the Brea-Olinda highway and some streets at La Habra, 2.45 miles in all, has been awarded to Steele Finley, Santa Ana, for $16,479.20; other bidders were Wells & Bressler, $17,-197.05; W. E. Hall, $17,992.54; A. E. Wright, $19,343.55.

Contract for improvement of streets near factory of Anaheim Sugar Co. has been awarded to A. G. Wright for $2803.70.

Santa Ana, Cal.—Homer Hamlin, consulting engineer employed to report on routes for the road in Santa Ana canyon, has reported against construction of highway along river at Sulphur Slide and plans will be prepared for road on the ridge. Estimated cost is $60,000.

Santa Barbara, Cal.—Marriott & Edwards were the only bidders at $20,000 for improvement of the Guadalupe-Santa Maria road. Bid was rejected because too high, and work will be done by day-labor.

Santa Fe, New Mexico.—Federal Government has approved ten projects for co-operative road-building, work to be done during the next two years. Total estimated cost is $600,000.

Seattle, Wash.—Contract for construction of brick pavement on Rainier avenue has been awarded to Nettleton-Bruce-Eschbach Co., American Bank Bdg., Seattle, for $130,-365.

Contract for improvement of Howard avenue has been

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awarded to V. Bressi & Co., 853 Rainier avenue, Seattle, for $29,078.75.

Contract for paving Beacon avenue has been awarded to R. G. Stevenson for $30,914.

Tacoma, Wash.—Bids will be received until July 11 by county commissioners for construction of Carbonado-Belmont road, 1½ miles.

Terra Bella, Cal.—Contract for construction of warrenite pavement on concrete base on Main street has been awarded to J. M. Nelson, Visalia.

Tulare, Cal.—J. E. Lee, Pasadena, was low bidder for construction of 4-in. concrete pavement on several streets at $0.80 per cu. yd. for excavation, and $11.90 per cu. yd. for concrete pavement, a total of $38,102. Other bidders were Kaufield & Tompkins, $41,455; George A. Rogers, $42,231; M. T. Shafer, $45,628.40.

Ukiah, Cal.—Contract for construction of the Balavichy Springs road has been awarded to Ford & Tuck, Ukiah, for $1530.

Vancouver, Wash.—Contract for improvement of highway between Vancouver and Camas has been awarded to O. D. Wolf, Washougal, for $32,780. United Construction Co. bid $34,098.38 and Elliott Construction Co., $35,000.

Visalia, Cal.—Contract for construction of the Lindsay-El Mirador division of the county highway system, 3.24 miles, has been awarded to Brady & Flinn, Humboldt Bank Bdg., San Francisco.

Contract for construction of the Woodville-Tipton highway, 7.3 miles, has been awarded to Concrete Pipe & Construction Co., Porterville.

Contract for construction of the Paige-Waukena highway, 7.5 miles, has been awarded to the Isbell Construction Company.

Bids of White & Gaskill and the Isbell Construction Co. for the construction of the Woodlake-Visalia highway, 11 miles, were taken under advisement but later rejected because of lack of funds.

Watsonville, Cal.—Contract for improvement of Main street has been awarded to Granite Rock Co., Salinas, at about $0.095 per sq. ft. for macadam pavement, or a total of $3418.

Willows, Cal.—Contract for paving Tehama street has been awarded to the Brush-Howard Co., Santa Rosa, for $1700.

SEWERS AND DRAINAGE

Los Angeles, Cal.—John Balch was low bidder at $5700 for construction of vitrified-pipe sanitary sewer on Denison avenue.

Napa, Cal.—Contract for construction of sewer on Georgia street has been awarded to Frank Gaggero, Napa, at the following unit prices: 6-in. sewer, $0.65 per ft.; wye-branches, $1.25 each; brick manholes, $55 each; flushing-holes, $9 each, a total of $408.

Richmond, Cal.—Contract for construction of sewers in the Brown Andrade and the Overland tracts has been awarded to T. B. Clinch, Richmond, for $3996.23.

Salt Lake City, Utah.—Bids will be received until July 9 by Gordon Snow, city recorder, for construction of sewer on Sunnyside avenue.

San Francisco, Cal.—Contract for improvement of Guttenberg and Hanover streets has been awarded to J. F. Dowling at the following unit prices: 8-in. vitrified sewer, $3 per ft.; 12-in. sewer, $3.50 per ft.; 15-in. sewer, $4 per ft.; brick manhole, $100.

Contract for construction of sewers on Tioga avenue between Rutland and Alpha streets has been awarded to J. F. Dowling at $2.50 per ft. for 8-in. sewers, $1 each for wye-branches, and $110 each for brick manholes.

Santa Barbara, Cal.—Contract for construction of sewer on Padre street has been awarded to S. J. Krull for $386.

Ukiah, Cal.—Bailey-Comstock Co., Santa Rosa, was low bidder at $6622.13 for construction of sewage-disposal system.

Stockton, Cal.—Contract for construction of sewage-disposal plant for sewage from northern part of city has been awarded to John Heafey, Oakland, for $76,000. Cahill-Vensano Co. bid $82,500 and Frank C. McIntire, $86,949.

BRIDGES AND CULVERTS

Astoria, Ore.—Contract for construction of bridge over Northrup creek has been awarded to O. L. Johnson for $1779.50.

Colfax, Wash.—Contract for construction of the Parvin bridge has been awarded to H. C. Mallott, Seattle, for $13,995.

Eureka, Cal.—Following bids were received for construction of reinforced concrete approaches to the bridge across Eel river at Fernbridge: Henry Padgett, $42,150; Thomas Englehart, $53,000; Elsemere & Jacobs, $56,000; Mercer-Fraser Co., $63,700. All Eureka bidders. All bids were rejected and work will probably be postponed indefinitely.

Eureka, Cal.—Bids will be received until July 9 by Fred M. Kay, county clerk, for construction of a wooden bridge on the state highway across East Branch creek three miles south of Garberville.

Healdsburg, Cal.—Contract for construction of concrete bridge over the slough on Matheson street has been awarded to L. Lambretti, Mill Valley, for $1595. Other bidders were Call Construction Co., $1649; Bailey-Comstock Co., $1893; L. G. Bergren & Son, $2922.

Martinez, Cal.—Contract for construction of reinforced concrete bridge on State highway across Rodeo creek has been awarded to C. H. Gildersleeve, the only bidder for $5385.

Bids will be received until July 8 by J. H. Wells, county clerk, for construction of a combination swing-drawbridge across Taylor slough.

Merced, Cal.—Bids will be received until July 15 by P. J. Thornton, county clerk, for construction of reinforced concrete bridge over the Merced river about three miles from Hilmar.

Oakland, Cal.—War Department has refused permission for construction of bascule bridge across Oakland estuary until after the War.

Olympia, Wash.—Contract for construction of 270-ft. steel bridge across the Cowlitz river on the National Park highway in Lewis county has been awarded to C. G. Huber, Central Bdg., Seattle.

Red Bluff, Cal.—Bids will be received until July 9 by H. G. Kuhn, county clerk, for construction of steel bridge across south fork of Cottonwood creek.

Reno, Nev.—Bids will be received until July 5 by county commissioners for construction of bridge across Truckee river.

Sacramento, Cal.—Bids will be received until July 15 by State Highway Commission for construction of a reinforced concrete bridge containing eight 30-ft. spans across Outlet creek three miles north of Willits.

De Waard Bros., San Diego, were low bidders at $25,373 for construction of six reinforced concrete bridges on the state highway in Shasta county across Sulphur, Boulder, Churn, Salt, Moody, and Spring Branch creeks. The lengths are 80, 46, 230, 45, 45, and 45 ft. respectively. Bordwell & Zimmermann, Calistoga, bid $29,398. Engineers' estimate was $32,501.39.

De Waard Bros. were the only bidders for construction of two reinforced concrete bridges on the state highway in Shasta county across Slate and Denny creeks. The lengths are 60 and 30 feet.

Salinas, Cal.—Contract for construction of bridge across Thompson's gulch near King City has been awarded to Daniel R. Wagner & Co. for $10,690. There were three other bidders.

San Jose, Cal.—Bids will be received until July 8 by H. A. Pfister, county clerk, for construction of five reinforced concrete bridges on the Pacheco Pass road.

Following bids were received for construction of reinforced concrete bridge across Coyote creek at Santa Clara street: Bos & O'Brien, $66,700, or $59,800 if city will furnish cement. C. L. Wold & Co., $67,600, if city furnishes cement. Tibbitts-Pacific Co., $73,248, or $64,600 if city furnishes cement. If wooden piles are used instead of concrete, $66,248 or $58,248 if city furnishes cement. Eaton & Smith, 407 11th street, San Francisco, $64,800 or $55,800 if city furnishes cement. If city will accept personal instead of surety-company bond, $1000 will be deducted from each bid. Contract has been awarded to Eaton & Smith.

San Luis Obispo, Cal.—Contract for construction of bridge across Pico creek has been awarded to T. Maino, San Luis Obispo, for $3800. F. F. Moore Co. bid $3895.

Santa Ana, Cal.—Chris McNeill, Santa Ana, was low bidder and was awarded contract at $46,812.83 for construction of the Main Street bridge. Other bidders were Henry Clark Co., $49,715.52; George W. Harding, $53,726.50; W. M. Ledbetter, $57,657.55; Ross Construction Co., Sacramento, $71,982.50.

Wells & Bressler, Santa Ana, were low bidders and were awarded contract at $11,175 for construction of the Flower Street bridge. Other bidders were Chris McNeill, $11,804; W. M. Ledbetter, $12,161; Henry Clark Co., $12,225.50; George W. Harding, $12,650. All Los Angeles bidders on both these jobs unless otherwise noted.

Santa Rosa, Cal.—Plans have been prepared and call for

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bids will be issued soon for repairing the bridge across Russian river at Geyserville. Estimated cost is $10,000.

Seattle, Wash.—Contract for construction of steel bridge across the south fork of the Snoqualmie river at North Bend has been awarded to C. C. Snyder & Co., Pacific Block, Seattle, for $13,132. Other bidders were Fleines & Dahl, $14,500; Thomas Hansen, $14,950; J. R. Wood, $16,400; Portland Bridge Co., $16,780; Charles G. Huber, $16,790.

Twin Falls, Ida.—Contract for construction of 608-ft. steel suspension bridge near Hansen has been awarded to Midland Bridge Co., Kansas City, for $92,850.

IRRIGATION AND WATER SUPPLY

Cold Hill, Ore.—Contract for construction of irrigation system for Gold Hill irrigation district has been awarded to W. A. Kraner, Rialto Bdg., San Francisco. District contains 6000 acres.

El Paso, Tex.—Bids will be received until July 16 at office of U. S. Reclamation Service for construction of canals on the Rio Grande project, requiring 30,000 cu. yd. excavation. Work is near Clint, Texas.

Madera, Cal.—Louis C. Hill, Hollingsworth Bdg., Los Angeles, consulting engineer for the proposed Madera irrigation district, has reported that borings at the site for the proposed dam at Millerton indicate that foundation conditions are good.

Oroville, Cal.—Report of H. A. Kluegel on the Wyandotte irrigation project as completed by C. E. Grunsky of San Francisco has been made public. The proposed system includes a small diverting-dam on Lost creek, a multiple-arch concrete storage-dam at New York flat, and a distribution system. Total estimated cost is $1,000,000 plus the price fixed for the present system. It will not be necessary to construct the entire system at once; in fact, the construction period can be extended over ten years. System will cover 30,000 acres.

Palo Alto, Cal.—Board of Public Works has been authorized to construct additional pumping station, including drilling well. Total estimated cost is $9000.

Salem, Ore.—State Desert Land Board has awarded contract for construction of the first unit of the Jordan Valley irrigation project, comprising 38,000 acres to Maney Bros., Boise, Idaho. Construction of the second unit comprising 18,000 acres has been postponed.

San Francisco, Cal.—State Water Commission has granted the following permits to divert water for irrigation:

S. A. Hansen, Oakdale, two second-feet from tributary of Tuolumne river. Plans include pumping plant.

Holecek Bros., Hamilton, one second-foot from Sacramento river. Plans include pumping plant. Estimated cost is $2000.

W. M. Ferris, Valleton, 15/100 second-foot from springs. Plans include 6-in. concrete pipe-line 6000 ft. long.

P. B. Cross, San Francisco, 110 second-feet from Sacramento river near Sidds Landing. Plans include 42-in. centrifugal pump, 500-hp. motor, and canal 14 miles long. Estimated cost is $100,000.

Chicago-California Development Co., Sacramento, 410 second-feet from Sacramento river in Sutter county. Plans include three 48-in. centrifugal pumps, connected to 175-hp. motors, and main canal two miles long. Estimated cost is $530,000.

Sutter Basin Co., Sacramento, 142 second-feet from Sacramento river in Sutter county. Plans include centrifugal pumps, motors, and main canal. Estimated cost is $182,500.

W. H. Metson, San Francisco, 13½ second-feet from tributary of San Joaquin river in San Joaquin county. Estimated cost of work is $10,000.

Vancouver, B. C.—Contract for construction of the East Seymour water system has been awarded to Canadian Pipe Co., Vancouver, for $24,217.20, using wood-stave pipe. Other bidders were Moon & Silverton, $24,500, and Barr & Anderson, $31,210.95. Engineer's estimate was $24,567.

LIGHT, HEAT, AND POWER

Portland, Ore.—War Finance Corporation has approved loan to Northwestern Electric Co. of $1,000,000 for extensions and betterments.

San Francisco, Cal.—State Water Commission has granted permit to Marcus Pluth, Los Angeles, to divert 10 second-feet from Snow creek and 20 second-feet from Whitewater river for power for a portland-cement mill and for sale. Plans include low concrete dams, and canals and flumes. Total estimated cost is $215,000.

RIVER AND HARBOR WORK

Garden Grove, Cal.—Southern California Fence Construction Co., Los Angeles, has been awarded contract at $4500 for furnishing woven-wire fencing, barbed wire, staples, and spikes to Garden Grove storm-water district. H. S. Lake, Garden Grove, has been awarded contract for furnishing redwood piles at $5061. George McGirk, Santa Ana, was low bidder at $0.12 per cu. yd. for construction of 60,000 cu. yd. of levee-embankment.

Oakland, Cal.—Plans for co-operative development by the city of Oakland and the Southern Pacific Co. of the part of the waterfront south of the Oakland mole have been prepared. Total estimated cost is $25,000,000, most of which will not be spent until after the War.

Pacific Grove, Cal.—T. A. Work will construct wharf and shipbuilding plant.

San Diego, Cal.—All bids for dredging material at harbor have been rejected by the Federal Government because too high.

San Francisco, Cal.—Contract for construction of shed on pier 31 has been awarded by Board of State Harbor Commissioners to California Construction Co., 74 New Montgomery street, San Francisco, for $102,000. Other bidders were Hayes-Oser Co., $108,514; J. D. Hannah, $108,900; J. S. Hannah, $112,300; Robert Trost, $113,860.

Contract for repairing floor of pier No. 34 for Western Pacific Railway Co. has been awarded to Hyde, Harjes & Co., San Francisco, at $22 per M.B.M.

State Board of Harbor Commissioners has decided to construct new reinforced concrete pier in place of present pier No. 1. Work will be started as soon as the new pier No. 3 has been completed, probably about August 15.

Seattle, Wash.—Bids will be received until July 8 by county commissioners for construction of creosoted-pile dock at Quartermaster harbor.

RAILROAD WORK

Kellogg, Ida.—Federal Railroad Administration has approved construction of the Pine Creek branch of the Oregon, Washington Railroad & Navigation Co., 9.3 miles. Estimated cost is $300,000.

Port Angeles, Wash.—Chicago, Milwaukee & St. Paul Railway will construct 40 miles of railroad in Clallam county.

Spokane, Wash.—Plans are being made by Electric Point Mining Co. for construction of railroad between Leadpoint and New Boundary, 10 miles. Estimated cost is $150,000.

BUILDING CONSTRUCTION

Arcadia, Cal.—Contract for construction of Army balloon camp has been awarded to C. J. Kubach Co., Merchants National Bank Bdg., Los Angeles. Estimated cost is $400,000.

Arcata, Cal.—Contract for construction of school-building has been awarded to Englehart Paving & Construction Co., Eureka, for $52,925.

Bay Point, Cal.—Contract for construction of buildings for Bay Point Foundry Co. has been awarded to J. Pattinson, 925 Alameda street, Berkeley.

Billings, Mont.—Contract for construction of reinforced concrete hospital building has been awarded to Frank Jacoby & Son, Helena, for $266,000.

Crockett, Cal.—General contract for construction of several buildings for California-Hawaiian Sugar Co. has been awarded to Lindgren Co., Monadnock Bdg., San Francisco, on a cost-plus-percentage basis. Contract for furnishing steel has been awarded to California Steel Co., Hobart Bdg., San Francisco.

Eureka, Cal.—N. B. Ackerman was the only bidder for construction of extension of Winship school, at $20,581 for reinforced concrete and $18,972 for stucco. Bid was rejected.

Fresno, Cal.—Contract for construction of addition to warehouse for Griffin & Skelly has been awarded to F. J. Stone for $10,000.

Harrington, Wash.—Contract for construction of 100,000-bushel concrete grain-elevator for Harrington Milling Co. has been awarded to Hurley-Mason Co., Hoge Bdg., Seattle, for $35,000.

Kelseyville, Cal.—N. R. Coulter, 46 Kearny street, San Francisco, is preparing plans for frame-and-plaster schoolbuilding. Estimated cost is $15,000.

Lakeport, Cal.—N. R. Coulter, 46 Kearny street, San

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Francisco, is preparing plans for a reinforced concrete school-building. Estimated cost is $25,000.

Los Angeles, Cal.—Contract for construction of reinforced concrete warehouse at Hollywood for the Lasky Corporation has been awarded to the Jacobs Construction Co., Los Angeles.

Manteca, Cal.—Contract for construction of building for California Paste Co. has been awarded to H. J. Ross for $25,000.

Middletown, Cal.—N. R. Coulter, 46 Kearny street, San Francisco, is preparing plans for frame-and-brick hotel-building. Estimated cost is $15,000.

Modesto, Cal.—Supervisors of Stanislaus, Merced, Madera, and Mariposa counties have decided to join in construction of a tuberculosis sanitarium. Estimated cost is $50,000.

Monterey, Cal.—P. V. Tuttle, Pacific Grove, is preparing plans for reinforced concrete building to be constructed in New Monterey for Wing Chong & Co., 702 Grant avenue, San Francisco. Estimated cost is $15,000.

Niles, Cal.—Contract for construction of a reinforced concrete cannery and warehouse for Schuckl & Co. has been awarded to Braunton Bros., 180 Jessie street, San Francisco, for $60,000.

Oakland, Cal.—Contract for furnishing steel for mill-construction building for Remar Baking Co. at 46th and Adeline streets has been awarded to Western Iron Works, 141 Beale street, San Francisco.

Contract for repairing fire damage to the five-story brick building of St. Mary's College has been awarded to J. L. McLaughlin, 244 Kearny street, San Francisco, on a cost-plus-percentage basis.

Contract for plumbing, gas-fitting, heating, and ventilating for new building for Pacific Telephone & Telegraph Co. has been awarded to Carl T. Doell for $46,285.

Olympia, Wash.—Contract for construction of reinforced concrete hotel-building for the Olympia Hotel Co. has been awarded to Henrickson & Co., Globe Block, Seattle, for $200,000.

Palo Alto, Cal.—N. R. Coulter, 46 Kearny street, San Francisco, is preparing plans for brick school-building to be constructed at Ravenswood. Estimated cost is $20,000.

Patterson, Cal.—Mineral Products Co. will construct factory. Estimated cost is $200,000. R. J. Wyseur is superintendent.

Port Angeles, Wash.—Contract for construction of library building has been awarded to C. Kuppler, Seattle, for $13,000.

Portland, Ore.—Globe Grain & Milling Co. will construct reinforced concrete flour-mill. Estimated cost is $150,000.

Contract for making alterations in the Coleman building has been awarded to Hurley & Mason for $65,000.

Riverdale, Cal.—Riverdale Co-Operative Creamery will construct addition. Estimated cost is $15,000.

Sacramento, Cal.—Contract for construction of reinforced concrete rice-mill for National Rice Mills Co. has been awarded to E. L. Younger, Woodland. Estimated cost is $250,000.

Northern California Milk Producers' Association, California Fruit Bdg., Sacramento, will construct creamery. Estimated cost is $150,000. The site has not been selected yet.

Herman Lawson, 344 Fourth avenue, San Francisco, was low bidder at $33,298 for plumbing, sewers, gas-fitting, heating, and ventilating for main building for Humboldt State Normal School. Other bidders were Robert Dalziel Jr., $33,317; F. W. Snook Co., $33,333; Scott Co., $34,935; F. J. Klimm, $34,993; Arthur Hess, $35,626; J. E. O'Mara, $36,340; James & Drucker, $38,250; Carl T. Doell, $40,703.

L. G. Bergren & Son, Call Bdg., San Francisco, were low bidders at $198,472 for construction of main building for Humboldt State Normal School. Other bidders were R. W. Moller, $218,850; P. R. Ward, $219,490; P. F. Reilly, $223,000; Lange & Bergstrom, $224,700; E. E. Etherton, $239,850; Thomas Englehart, $242,000; Hayes-Oser Co., $248,000.

Louis Cereghino & Son, 180 Jessie street, San Francisco, were low bidders at $28,845 for construction of buildings at the Sonoma State Home at Eldridge.

Salt Lake City, Utah.—Contract for construction of addition to the Ensign school has been awarded to E. Chytraus & Sons for $14,203.

Contract for construction of addition to the Sumner school has been awarded to Anderson & Carlson for $24,630.

San Diego, Cal.—Following bids were received at the local public works office for construction of buildings at naval aviation school at North island: Lange & Bergstrom, San Francisco, item 1, $283,949; item 2, $431,321. Henry Clark Co., Los Angeles, $325,533 and $504,359. C. J. Kubach Co., Los Angeles, $329,620 and $508,644. Bids were also opened at Washington, but news regarding these bids has not been received yet.

Contract for construction of dirigible-hangar at the naval aviation school has been awarded to Lange & Bergstrom, San Francisco.

Contract for construction of frame theatre-building at Camp Kearny has been awarded to John Roberts Construction Co., San Diego, for $30,000.

San Francisco, Cal.—Contract for construction of reinforced concrete boiler-factory on Main street between Howard and Folsom, for Pacific Coast Boiler Works, has been awarded to Barrett & Hilp, Sharon Bdg., San Francisco, on a cost-plus-percentage basis. Estimated cost is $10,000.

Contract for construction of steel and corrugated-iron factory-building on Treat avenue near 18th street for Pacific Foundry Co. has been awarded to Cahill-Vensano Co., 110 Sutter street, San Francisco, for $45,000.

Contract for construction of reinforced concrete warehouse and grain-elevator to be built on Islais creek for Rosenberg Bros. has been awarded to Clinton Construction Co., 140 Townsend street, San Francisco, for $200,000.

J. R. Miller, Lick Bdg., San Francisco, is preparing plans for frame office and cafeteria building for Risdon Iron Works at 20th and Illinois streets. Estimated cost is $100,000.

Philippine Vegetable Oil Co., 1 Drumm street, San Francisco, will construct two reinforced concrete buildings at its plant on Japan street.

Contract for construction of building on Taylor street near Sutter for a Japanese club has been awarded to E. T. Leiter & Sons, San Francisco, for $21,598.

Following sub-contracts have been awarded for construction of class A addition to Mills building: carpentry, concrete, and masonry work to Dinwiddie Construction Co. Hardware to Palace Hardware Co. Vitrolite to Vitrolite Co. Steel to California Steel Co. Glass to W. P. Fuller Co. Electric wiring to Globe Electric Co. Ornamental-iron work to Sartorius Co. Reinforcing-steel to Woods, Huddart & Gunn. Terra cotta to Livermore Fire Brick Works, Livermore. Elevator to Otis Elevator Co. Terrazzo to Henry Gervais. Plumbing to C. Petersen Co: Heating to Robert Dalziel Jr. Roofing to Johns-Manville Co. All San Francisco firms unless otherwise noted.

Contract for construction of addition to concrete garage on Sutter street between Taylor and Mason has been awarded to Ruegg Bros., Pacific Bdg., San Francisco, for $18,900.

Seattle, Wash.—Contract for construction of concrete buildings for the Centennial Mill Co. has been awarded to Hurley-Mason Co., Hoge Bdg., Seattle, for $54,000.

Contract for construction of steel and mill-construction building for Gulowsen-Grei Engine Co. has been awarded to M. Arveson, Downs Block, Seattle, for $123,500.

P. A. Harrington & Co., Whatcom and Hanford streets, Seattle, were low bidders at $99,600 for construction of salmon-storage warehouse for Port of Seattle Commission. Other bidders were Western Construction Co., $103,000; McRae Bros., $108,788; Swansson & Co., $112,725. Plans were revised and contract awarded to P. A. Harrington & Co. for $71,500.

Contract for construction of Crown Hill school has been awarded to John Larson, 4103 Ashworth avenue, Seattle, for $24,725.

All bids for construction of Daniel Bagley school have been rejected and plans will be revised.

Stockton, Cal.—Board of Education has decided to construct machine-shop at high school. Estimated cost of building is $11,500 and of equipment, $8700 additional.

W. J. Scott, Edison street, Stockton, was low bidder at $44,054 for construction of school building.

Taft, Cal.—P. A. Needham, Taft, is preparing plans for fire-house to be constructed under the bond issue recently voted. Estimated cost is $15,000.

Turlock, Cal.—Recent court decision has removed obstacles to construction of high-school building.

Vallejo, Cal.—Lange & Bergstrom were low bidders at $7942 for construction of frame time-and-chronometer station at Mare Island Navy Yard. Frank Gallagher bid $8125 and Schultz Construction Co., $8294. All San Francisco bidders.

Contract for altering brick brewery-building to apartment-house for H. Widenmann has been awarded to W. D. Henderson, Monadnock Bdg., San Francisco, for $26,000.

Woodlake, Cal.—Rea & Garstang, Black Bdg., Los Angeles, are preparing plans for concrete packing-house for G. F. Stevenson.

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BONDS

Corcoran, Cal.—Bond issue of $70,000, $22,500 for purchase of old water-system and $47,500 for extensions has been voted. Plans include drilling another well, steel tank, and distribution system. L. M. Stone is city engineer.

Kingsburg, Cal.—Bond issue of $27,000 for construction of sewage-disposal plant has been sold to William R. Staats Co., Los Angeles, at a premium of $418. These bonds bear 6% interest.

Lakeport, Cal.—Bids will be received until July 8 by S. Mathews, county clerk, for the purchase of $25,000 worth of bonds of Upper Lake Union high school district.

Long Beach, Cal.—Bond issue of $263,500 for harbor-improvements has been sold to John F. Craig, the only bidder, at par and accrued interest. These bonds bear 5% interest.

Los Angeles, Cal.—Capital Issues Committee has approved bond issue of $1,000,000 for flood-control in Los Angeles county, $835,000 of which is for purchase of right-of-way, and $165,000 for construction of bridges.

In addition to $1,000,000 worth of county flood-control bonds already approved, the Capital Issues Committee has not approved $1,250,000 more, making $2,250,000 in all. The total proposed issue was $4,500,000. The amount now approved will permit commencing construction of the diversion channel in addition to purchase of right-of-way.

Merced, Cal.—W. H. Lynch, engineer for the U. S. Office of Public Roads, is making an investigation of the proposed bond issue of $1,250,000 for construction of county highway system.

Modesto, Cal.—Bond issue of $75,000 in Modesto irrigation district for construction of drainage ditches failed to receive the necessary two-thirds majority.

Bond issue of $110,000 for construction of school buildings failed to receive the necessary two-thirds majority.

Olinda, Cal.—Bond issue of $615,000 for extension of irrigation system has been voted in Happy Valley irrigation district. Of this amount, $210,000 will be sold at once for the construction of dam and tunnel.

Portland, Ore.—Capital Issues Committee has approved issuance of $690,000 worth of State highway bonds.

Salinas, Cal.—Bond issue of $24,000 for reclamation district No. 1665 has been sold to the Salinas City Bank at par and accrued interest. The bonds bear 6% interest.

San Francisco, Cal.—No bids were received by Board of Supervisors for the purchase of $435,000 worth of school bonds and the bonds will be sold 'over the counter' by the city treasurer.

Santa Barbara, Cal.—Cyrus Pierce & Co., San Francisco, bid $1557 plus par and accrued interest for the $500,000 issue of bonds for improvement of water system, including construction of Gibraltar dam. Anglo-London-Paris Bank bid $915 premium plus par and accrued interest.

Tracy, Cal.—Bond issue of $15,000 for extensions to sewer and water systems has been sold to McDonnell & Co., San Francisco, for $15,632. These bonds bear 6% interest.

MACHINERY AND SUPPLIES

Berkeley, Cal.—All bids for furnishing gravel, crushed rock, and screenings to city have been rejected because too high and supplies will be purchased in the open market.

Los Angeles, Cal.—A. H. Busch Co. was low bidder for furnishing standard screw pipe to city at the following unit prices: ¼-in. pipe, 6.05c. per ft.; ¾-in., 7.15c.; 1-in., 12.07c.; 2-in., 24.93c.; a total of $5436.75.

Oroville, Cal.—Board of Supervisors has appropriated $2500 for purchase of fire extinguishers and other fire-fighting equipment for county fire-districts.

Red Bluff, Cal.—Bids will be received until July 9 by H. G. Kuhn, county clerk, for furnishing 20,000 ft. of lumber, two 6-horse road-graders, and miscellaneous quantity of picks, shovels, sledges, and spikes.

San Francisco, Cal.—Bureau of Foreign and Domestic Commerce, 307 Custom House, has information regarding man in Chile that is in the market for a 3½-ton motor-truck. Refer to No. 26980.

Contract for furnishing steel rails and accessories for Hetch Hetchy project has been awarded to Sierra Railway at $64 per ton for rails and $2.86 per 100 lb. for track-spikes.

Contract for furnishing 1000 ft. of 1-in. rubber chemical-hose to Fire Department has been awarded to Bowers Rubber Co. at $0.72 per foot.

Santa Barbara, Cal.—Contract for furnishing 7500 bbl. of cement to county has been awarded to Pacific Coast Coal Co., for $22,350.

Seattle, Wash.—Contract for furnishing 70,000 lb. copper wire to city has been awarded to Standard Underground Cable Co. for $19,636.

MISCELLANEOUS

Eureka, Cal.—O. P. Ackerman bid $2.79 per rod and P. J. Anderson $3.12 for fencing the State highway between Arcata and Eureka. Bids were rejected because too high.

McKittrick, Cal.—San Francisco-McKittrick Oil Co. will construct oil pipe-line from its property to Olig, 1½ miles.

Oakland, Cal.—Following bids were received for construction of concrete and granite bandstand at Lakeside park: R. W. Littlefield, $9875 or $7995, according to plans; Charles W. Heyer Jr., $10,095 or $8320; J. H. Pedgrift, $9839 or $8090.

Redwood City, Cal.—Burroughs & Son, San Leandro, were the only bidders for drilling a 10-in. well at the county farm at the following unit prices: $4 per ft. for the first 50 ft.; $4.50 for the second 50 ft.; and $5 for the third 50 ft.; county to furnish casing and drilling water.

San Francisco Shipbuilding Co. will construct four 7500-ton concrete ships at its shipyard near town. This is in addition to the eight ships to be constructed at the yard to be established on the Oakland estuary.

San Diego, Cal.—Bids will be received until July 3 by J. B. McLees, county clerk, for grading grounds around county tuberculosis hospital.

San Francisco, Cal.—State Water Commission has granted permit to Base Metals Co., Puente, to divert ¼ second-foot from streams in Inyo county for mining. Plans include pipelines 2½ miles long. Estimated cost is $3500.

Santa Barbara, Cal.—Contract for hauling 50,000 bbl. of cement from railroad to south portal of Mission tunnel, 5 miles, has been awarded to R. A. Baker & Son, Los Angeles, for $1.70 per ton.

Washington, D. C.—Contracts for construction of eight 7500-ton concrete ships each for Emergency Fleet Corporation have been awarded to Schofield Engineering Co. and to San Francisco Shipbuilding Co. Ships under the first contract will be constructed at San Diego and under the second on Government island in the Oakland estuary.

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